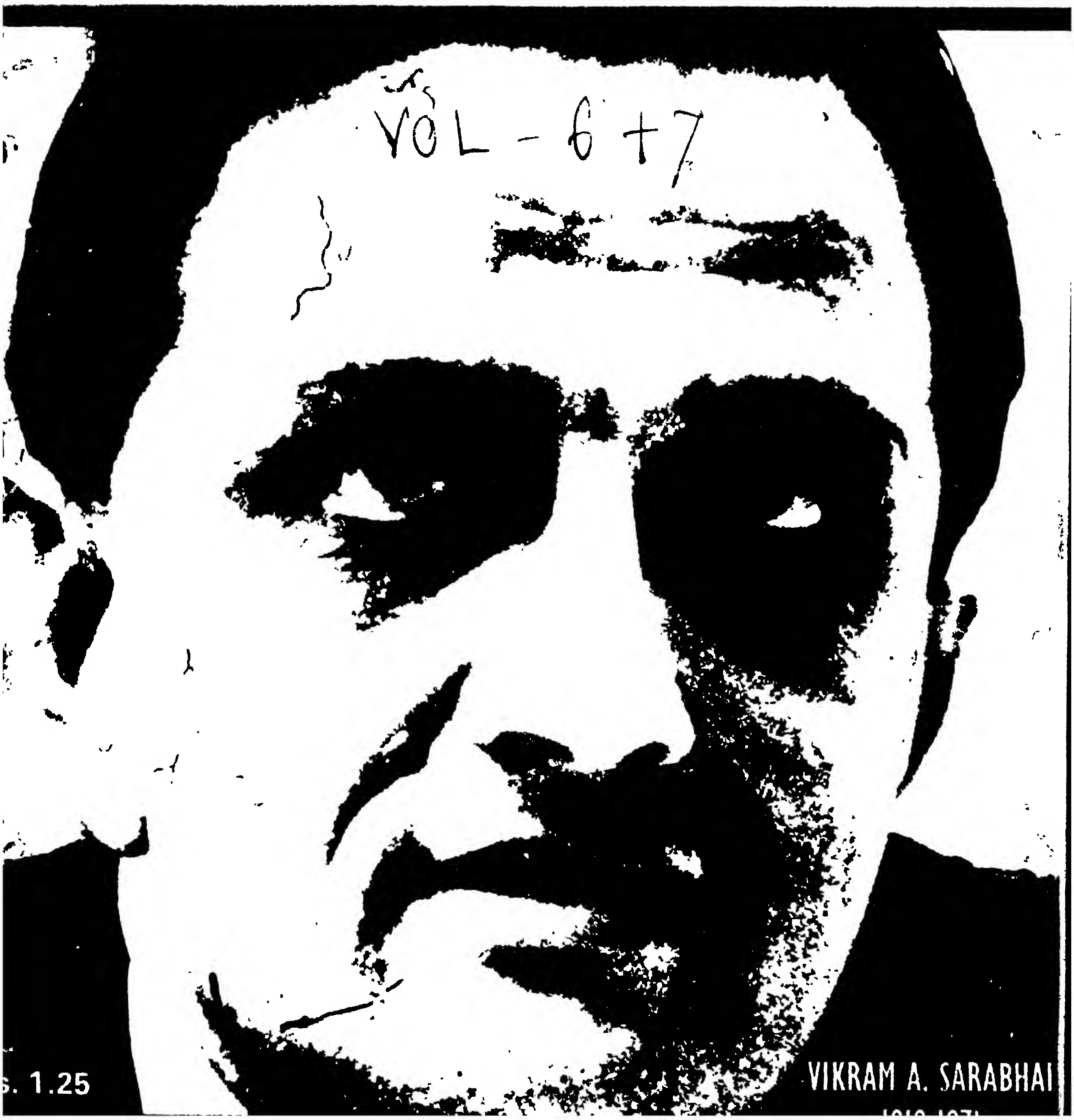
A TIMES OF INDIA PUBLICATION

JANUARY 1972

SCIENCE TODAY

FOR EVERYMAN



Vol. 6 No. 7 January 1972

SCIENCE TODAY

Annual Subscription Rs. 12·50
Single copy: Rs. 1.25; 10p

LETTERS

The bomb and bumbledom

THE following corrections may please be noted in my article "The Bomb" (SCIENCE TODAY, October 71). On page 56, 'IE factor' should be substituted for 'FPE factor'. In the figure on page 30, it is more appropriate to substitute 'U-235' or 'U-233' for 'Pu-239', though a plutonium bomb can be designed on similar principles if a provision can be made for reducing spontaneous fissions. Another design for the plutonium bomb exploits the spherical implosion from a shaped charge ignited by equally spaced ignitors. For such equal spacing, we have to use a familiar theorem in solid geometry which states that there cannot be more than five regular polyhedra. The number of nodes of these polyhedra, viz 4, 6, 8, 12 and 20, are also the possible numbers of ignitor points in the Pu bomb situated exactly at the nodes of a regular polyhedron inscribed in the spherical shell. The implosion shockwave compresses the sub-critical mass into a critical mass.

Now a few words on your note "Can We Make It?" Your quotation from *Washington Post* on India's bomb programme may be correct, but whether the paper's report is correct is open to question. Also, you have suggested organisational modifications some of which (steps 2 to 5) might have overlooked many a praiseworthy achievement made so far. Dr. Homi Bhabha trained people in the various organisations under the AEC; it is perhaps the largest group of highly talented research people in India, most of them known for their dynamism. Lapses, if any, are therefore not in the people but in the organisational structure. Your prescription of a sharp demarcation of responsibilities is, of course, timely but I do not agree with you when you suggest that active scientists should be held responsible.

Incidentally, the same issue carries a book (*The Medvedev Papers*) review entitled "Science and Bumbledom" by Prof. R. Narasimhan, which also draws questionable conclusions about the organisation of science in the country, though the review was written excellently. Prof. Narasimhan's advocacy of anarchy in science is totally irrelevant to us at this stage. In the USSR, within the framework of the socio-economic system they chose, an optimum trade-off between the expediency of economic growth and social freedom is being evolved. This has its impact on the organisation of science and technology too. In general, only the highly gifted are allowed to take up pure research; others are subject to different levels of control depending upon the identity of goals between the individual and society. When a social goal is preferred, inevitably the choice of the research problem taken up by the individual is the first casualty. This may be justifiable within the scope of the axioms of the Soviet way of life which consider the material well-being of the next generation more important than the absolute intellectual freedom of the present generation. However, the urge for intellectual freedom is so dominant that when a necessary level of material well-being is reached, it starts asserting itself. If Medvedev is angry about the regimentation in science, he should be talking about the past. For if he spoke out now, it is because he could. This shows a shift from control (emphasising society) towards a state of anarchy (emphasising the individual) in search of the optimum.

In India, the situation is quite opposite. A quantitative analysis of the functional infrastructure of science and technology here shows that the freedom allowed to our scientists and engineers is, in net terms, more than that allowed in countries like the USA and the USSR. In the US, a majority of the R & D scientists and engineers are bound to specific contracts with time-targets set by the funding agencies. The freedom is in the choice of the place of work; the choice of the project itself is limited by the larger goals of the organisation, which are governed by the objectives of the funding agencies. The fund the organisation gets depends on the extent to which it toes the line of the funding agencies which have a centralised structure. In the USSR, extensive aptitude tests determine one's area of work. Centralised organisations identify R & D projects which are handed over to scientists and workers down a hierarchy which is more horizontal than vertical and designed for a maximum organisational efficiency. The fierce competition between the US and the USSR is forcing both to an increasingly sharp definition of the projects and the time-targets. Inevitably, the formulation of the problem is becoming more and more a centralised function. And the so-called freedom of intellect is directly constrained in the USSR and indirectly in the USA.

In India, the situation is different because there were no centralised organisations to locate R & D projects in an integrated plan linked with national needs and assign them with time-targets to scientists and engineers. As a result, R & D activities in universities, national laboratories and public industries are too diffused and uncoordinated to make their impact felt. With no directed motivations, research workers tend to formulate their own problems and solve them. Most of the projects pursued are an end in themselves; continuity from one project to another is seldom maintained. Then there are those who return from developed countries and bring with them an experience which is, in many cases, irrelevant to our national needs. A large number of them tend to carry on here the work of the same nature. They bring into the system new concepts of freedom that are detrimental to economic progress as they are designed to perpetuate diffused and unorganised work. Inevitably, a class develops with its forces of survival. And when an enlightened leadership attempts to reform, organise and reorient, these forces resist.

To sum up, Prof. Narasimhan's conclusions are wrong because the USSR and India are moving towards similar optimum trade-off between growth and freedom in science, but from opposite directions — the former from control towards anarchy and the latter from anarchy towards control.

N. Seshagiri
Tata Institute of Fundamental Research, Bombay

Can we make the bomb?

THE special issue on the nuclear bomb (October 71) was timely. China's nuclear policy has paid it rich dividends in the form of a permanent UN membership.

However, a few omissions must be mentioned. In "Comparative Costs" (page 53), it is written that the cost of the three gigantic diffusion plants in the US was around Rs. 1,725 crores with an annual operating cost of Rs. 375 crores, i e Rs. 90,000 per kg of U-235. But it is to be noted here that this type of gas diffusion plant, which costs anything between Rs. 650 and 750 crores and consumes a lot of electric power (the three American plants together consume 6,000 mW), is not meant for countries like India. Even China and France did not go in for this method in a big way. The American plants have a total installed capacity of 17,000 tonnes of separation work a year (p. 46). A small plant, enough to supply fuel for three or four 190 mW nuclear-power stations of the Tarapore type, with an installed capacity of 100 tonnes will consume 35 mW of power and will cost no more than Rs. 40 crores, including Rs. 8 crores for a conventional coal-fired power station.

In "Separation of U-235" (p. 32), the centrifuge process has not been described fully with all the problems which are yet to be solved. The process, which requires a titanium or carbon fibre cylinder to spin steadily around its own axis at nearly 50,000 to 60,000 revolutions per minute, poses peculiar problems. An ordinary generator producing a 50 cycles current can spin a rotor only up to 3,000 rpm. The generator must be improved to a frequency of at least 1,000 cycles to give the rotor the required speed. Bearings and rotors that can stand the stress of so rapid a movement for a few months without showing the slightest signs of fatigue must be perfected and so should the arrangement for feeding the gas into the whirling centrifuge and taking it out in two separate streams. It would require a long time to develop all these at the BARC even in collaboration with leading industrial firms.

Similarly, for the nozzle method, special leakproof pumps are needed. West Germany has already put up a ten-stage pilot plant at Karlsruhe. If it succeeds, the BARC can hope to get all facilities under the recent Indo-German agreement on cooperation in this field. A nozzle separation plant to meet our enriched uranium demands would not cost more than Rs. 20 crores while according to the estimates (1960) of the original Ernold Zippe centrifuge, a plant producing 50 kg of 90 per cent enriched U-235 annually would cost around Rs. 975 million and entail an annual running cost of Rs. 97 million (p. 39, SCIENCE TODAY, September 70). After all, India can afford the nuclear bomb.

P. K. Saha
Delhi College of Engineering, Delhi

Piece-meal plans for flood control

"ON an Alternative to the Ganga-Cauvery Link" by Rama, "How to Get More out of Reservoirs" by K. S. Parikh and "Can We Control Floods?" by B. R. Shori and G. S. Jakhade (all September 71) were fine and timely. What is wrong with our flood control measures? I will take the Kosi river in north Bihar as an example. The river has been causing havoc in the area for long. Lord Wavell, who saw the 1944 devastation, initiated immediately a project (Khosla Plan) for building a high dam in the Himalayas with canals and power stations. The Rs. 154-crore plan was to take 17 years to complete. J. L. Savage, the American flood control expert, came and commended the plan. And work began. Then it occurred to men in power at Patna and Delhi that the large funds going to the Kosi should be better diverted to the Damodar in south Bihar and the Sutlej (Bhakra Nangal in Punjab). And despite much protest, work on the Kosi stopped in 1947. Seven years later when heavy floods sent up anguished cries, embankments were hurriedly put up. But the river continues to drown the people for whom the control measures were intended, and the evacuation and rehabilitation of people in the area is a perpetual problem.

Embankments do not check floods; they only shift them. The waters must flow somewhere. The hills and mountains can contain them if the rivers are dammed and the water led through canals. When the tributaries are embanked, the floods shift to the main river, the Ganga in this case, where a barrage in the lower reaches without dams and reservoirs in the catchment areas has increased the danger. Dams and reservoirs on the heights are, of course, expensive and not without dangers. But they are the best means we have so far. Besides, they provide water the year round for irrigation and power production.

Only, we must stop planning piece-meal. Let us work out sound regional and inter-regional projects, with their claims to the scarce resources and the benefits they bring to each region woven into a larger national plan.

Arunkumar Misra
C. M. College, Darbhanga, Bihar

Banning private cars

PRIVATE cars should be banned in big, crowded cities, Prof. Aditya Prakash suggested in his interesting "Reflections on Urban Planning" (September 71). I support this view. In fact, owning a private car is an unsocial act in our conditions. The reasons are: (*i*) it pollutes the air heavily; (*ii*) it is an uneconomic mode of transport, being equivalent to using 15 to 20 horses to carry one man weighing about 70 kg; (*iii*) it leads to the non-remunerative blocking of national resources since it remains unused most of the time; and (*iv*) it is the cause of several unquantifiable social ills.

We can use the public transport (which, however, needs to be improved) or engage a taxi when even minutes count. There can only be a few persons whose every minute is valuable all the time; in such cases, parent institutions can provide them with suitable transport. Prof. Aditya Prakash has limited his proposal to cities only. Reasons (*iii*) and (*iv*) given above would warrant an extention of the ban to small towns as well.

Rama
Tata Institute of Fundamental Research, Bombay

REFLECTIONS

"On an Alternative to the Ganga-Cauvery Link"

THE ONLY CHOICE

PROF. Rama has proposed ("Focus", SCIENCE TODAY, September 1971) the pumping of the Ganga waters to areas alongside the river to recharge the ground water table through seepage and the use of this water later for irrigation. Ground water supply in the basin is being already augmented by river waters on a large scale; extensive areas are irrigated under rice, sugarcane, etc in the monsoon in the large canal systems. Such irrigation will increase in the future. In many places, the farmers use the recharge later from shallow tubewells.

Preliminary studies have shown that even after taking into account the likely requirements of the Ganga basin itself, a large surplus of water will be available in the monsoon near Patna which can be diverted to other basins, most of which will have shortages of water in the next 25 or 30 years. These basins also have great variations in river flows from year to year. Prof. Rama's plan to use more water in the Ganga basin itself as an alternative to the proposed national grid is, therefore, not possible.

Detailed studies on the Ganga-Cauvery link-up are going on. The grid will have many feeder lines to serve lands which are not along the main line.

Dr. K. L. Rao

Union Minister of State for Irrigation and Power, New Delhi

SOME SNAGS

THE proposed Ganga-Cauvery link has not so far been proved to be hydrologically necessary. Tamil Nadu may not require additional water for irrigation and other purposes beyond utilising the surplus waters of the nearer rivers Penneru, Krishna, Godavari, etc. If the problem is only to dispose of the surplus flood waters of the Ganga, the distant Cauvery need not and cannot take it.

Besides, there is a snag in Rama's plan. Unless it is possible to 'drive in' the surplus flood waters into the aquifers at the rate at which flood waters are flowing, there is bound to be excess surface run-off. The infiltration rate of about one metre per hour assumed in the plan is not at all probable; the aquifer permeability rate is limited by the generally low permeability of surface layers. To give an idea, a typical catchment surface soil is likely to allow an infiltration of only about 40 mm per day in the dry condition falling to almost one mm per day as the same soil moistens more and more. Therefore the probability of 'driving in' the surplus waters into the aquifers is remote.

Secondly, enormous pumping has to be done to create storage space in the pores of the aquifers. What happens to this pumped water? Do the irrigation systems require all this amount of pumpage? Not likely. I feel that if Prof. Rama studies a typical basin and attempts to design a practical project instead of arguing in general terms, he will find that his proposal cannot be implemented economically, administratively and technically.

P. Kumaraswamy

Director, Irrigation Research Station, Poondi, Tamil Nadu

DEBATE ON ALTERNATIVES

A UN team of experts will soon arrive in India to study the Ganga-Cauvery link. This is an important national project, and one would have expected the Government of India to elicit opinions from India's engineers, scientists and others on the plan through the Press or through symposia. Since this has not been done, scientists should come forward and state their views. They should also appeal to our Parliamentarians to insist on a discussion on this issue and to demand that the assignment of the project to the UN be subject to Parliament's clearance.

Large rivers like the Ganga may be dammed in the upper mountainous reaches where the water can be used for power generation, which in turn will lead to industrialisation and more employment opportunities in the region, instead of in the plains near Patna as planned. The latter choice will lead to the submergence, to some extent at least, of fertile and populated lands. Any control structure in the plains is also bound to be a source of danger to millions. On the other hand, the former course will make water readily available for irrigation at the lower reaches also. Besides, the industrial development of the upper Himalayan reaches is important from the defence point of view.

One possibility, as Prof. Rama has suggested, is to make "localised" plans for each river, i e the Ganga valley conservation plan should be based entirely in the Ganga basin. Another alternative is to construct, along each major river prone to floods, a number of side channels leading to the nearest desert or arid region, where the water can be stored in structures like tubewells. Each channel would be connected to the main river by sluice-gates to be lifted when the river rises above the danger level. The course of the channels may be planned so that the flood waters flow under gravity. This would be cheaper than pumping the Ganga waters to a height and taking them as far as the Cauvery basin. We can also consider diverting the waters of some rivers or part of their flow towards deserts through such channels permanently or during the monsoon when excess water is available. River Saraswati is a natural example. This would help irrigate the deserts; potable river water will no more be wasted. The melting of snow and ice is an important source of water for the Himalayan rivers even in the monsoon. This source should be evaluated by field studies.

The idea of linking up rivers is certainly welcome from the point of view of flood control, mitigation of famine

and the development of inland waterways. However, would it not be advisable to start with localised projects for each basin, i e the Ganga basin, the Cauvery basin, etc? The final link-up of the basins may be put off till detailed ground (geomorphological) and other environmental and ecological studies are done.

In the USSR, the Volga and the Don are connected with a view to diverting water from sparsely populated regions to more populated regions. In the US, the Mississippi is diverted to the west by damming it in the upper reaches to control floods and to utilise the water in a better way. Do these examples hold good in the case of the proposed Ganga-Cauvery link-up?

The answers should be sought at a national symposium.

A Reader

Prof. Rama replies:

I AGREE with Dr. K. L. Rao's contention that even after implementing the alternative project as I suggested, there would be considerable surplus discharge in the Ganga during the monsoon. A part of this could be diverted into the national grid. The proposal can therefore be an alternative only in the sense that if found workable and much cheaper, it could be taken up first. I must, however, clarify certain points raised in these columns.

The proposal is not for pumping the river water to areas alongside to recharge the groundwater table; this is expensive and ineffective. Nor does the proposal envisage the recharging of aquifers by spreading the monsoon waters over agricultural fields where the top soil is generally very impermeable. These (and several other) well-known methods of recharging are not practicable in the Ganga basin.

Here is the actual plan. The local run-off flows into the *seasonal streams* and from there to perennial channels by natural drainage. We should withhold the local run-off before it reaches the perennial rivers, i e the proposal is to withhold the discharge of the seasonal streams. But then where to put it? In the aquifers, under the sandy beds of the seasonal streams? Yes. But since they are already full even in the dry season, empty them deliberately. This should be done *only during the dry season* when the pumped water can be used for agriculture, either locally or by augmenting the canal supply. The aquifer may not get filled automatically during the monsoon by percolation through the *sandy beds of the seasonal streams*. And also, the entire discharge may not seep through, so that enough residual discharge is left to carry the silt with it. A part of the local run-off will still end up in the Ganga channel while a considerable fraction is withheld in the underground reservoirs below the beds of the seasonal streams

AWARDS & APPOINTMENTS

Eight persons have won the Indian Council of Medical Research awards for outstanding work in 1971. The Council has also awarded a prize for 1970.

The following have been awarded Rs. 1,000 each: **Dr. P. G. Talwar,** Professor of Biochemistry, All-India Institute of Medical Sciences, New Delhi, for biochemical studies; **Dr. R. V. Wardekar,** ex-director of the Gandhi Memorial Leprosy Foundation, Wardha, for social work in leprosy; and **Prof. Usha K. Luthra,** Deputy Director-General, ICMR, New Delhi, for studies in experimental oral carcinogenesis. Prof. Luthra has also been awarded a gold medal.

Four prizes of Rs. 500 each have been awarded to **Dr. M. S. Bamji,** senior research officer, National Institute of Nutrition, Hyderabad, for her work on nutritional status in the body; **Dr. B. D. Chatterjee,** Associate Professor of Bacteriology, School of Tropical Medicine, Calcutta, for studies on *V. parachaemolyticus;* **Dr. Gurkirpal Singh,** senior research officer, S. N. Medical College, Agra, for detecting arbo virus inhibiting antibodies in chicken sera; and **Mr. D. M. Vasudevan,** Devavilas, Kerala, for work on immune cytolysis of human uterine cervix carcinoma cells. Besides, **Dr. D. J. Jussawala** of the Tata Memorial Cancer Hospital, Bombay, wins a prize for work in epidemiology of cancer.

For the year 1970, a prize of Rs. 900 has been awarded to **Dr. P. K. Haldar,** Director, Institute of Radiology and Cancer Research, Kanpur, for work on radiotherapy for oral cancer.

ABOUT THE AUTHORS

PRAVINA MEHTA, who led the interview with R. Buckminster Fuller, is an architect-planner practising with a consultancy firm in Bombay. Currently, she is a consultant to the City and Industrial Development Corporation (CIDCO) set up by the Maharashtra Government for its twin-city project near Bombay. She was, in fact, one of the originators of the plan in 1964.

Miss Mehta worked in the US for some time after doing her BA in Architecture from the Illinois Institute of Technology and MA in Planning from the University of Chicago in 1954. During 1949–50, she attended the Seminar at the Institute of Design directed by Buckminster Fuller. She also worked on the project, "Planning Self-help Housing for India", on her return to India.

S. C. MAHESHWARI and SUDHIR K. SOPORY (*Plants from Pollen Grains*) are at the University of Delhi. Dr. Maheshwari is Professor in the Department of Botany. After taking his PhD from the Delhi University, Maheshwari studied at Yale University and the California Institute of Technology, USA, and later worked at Oxford University for some time. His research interests are the physiology and biochemistry of plant growth and differentiation. Sopory has been doing research on the production of haploid embryos and pollen for the last three years.

SCIENCE SHAPES LIFE

DAYTIME DREAMS

Are there any differences in the nature of dreams one gets during daytime naps and in the night? Analyses show that daytime dreams have less of fantasy. They also have fewer elements of an aggressive nature. However, they contain more contemporary references and familiar settings than the night dreams. On the other hand, night dreams involve more aggressive impulses and strange settings.

The study by a US psychologist covered 16 male and 17 female college students who had afternoon naps and slept an average of 7·9 hours in the night. The differences in the dream contents might be because of differences in sleep, stages from which the dreams were recalled or because of the variations in the length of the sleep, the study suggests.

HONESTY ISN'T THE BEST POLICY

The wise may say honesty is the best policy. But not so when a new job is at stake; honesty does not seem to be the best policy in filling out job application forms, shows a US study. Fifty-seven per cent of the subjects out of a sample of 111 gave inaccurate information on the duration of previous employment and salary. Both were overestimated. Another point where there was much dishonesty was the reason for leaving the previous job. However, on the nature of the previous employment most of the applicants were honest.

ABNORMAL BEHAVIOUR?

Is a belligerent, negative, distrustful and unstable young boy abnormal in his behaviour? Or are nervousness and helplessness negative traits in a young housewife? No, says a study reported by the US Department of Health, Education and Welfare. Maybe in others they are abnormal, but not for a particular age group or class. For, behavioural norms vary widely according to age, sex, marital status and social class, in that order.

Women are generally more nervous, helpless and anxious. In widows, divorced or remarried women, these symptoms are more marked than in young housewives. Wealthy men from the upper social class are more reserved than men in the lower rungs. Such men also tend to withdraw from family life. Teenagers are usually belligerent and unstable. All these, however, are not pointers of mental instability, says the study, which covered 450 persons. What may be anxiety in a husband may only be a mild apprehension in his wife.

SALIVA TEST FOR BIRTH CONTROL

A saliva test that predicts fertile periods in women from one to five days ahead has been reported to the American Chemical Society. The test employs a strip of chemically sensitive tape that a woman holds in her mouth briefly each day. The tape registers the level of a chemical enzyme which is found in the saliva and apparently varies during the phases of a woman's menstrual cycle. The tape, which will be particularly useful to women who prefer natural methods of birth control, will not be sold on the market until additional studies have been performed.

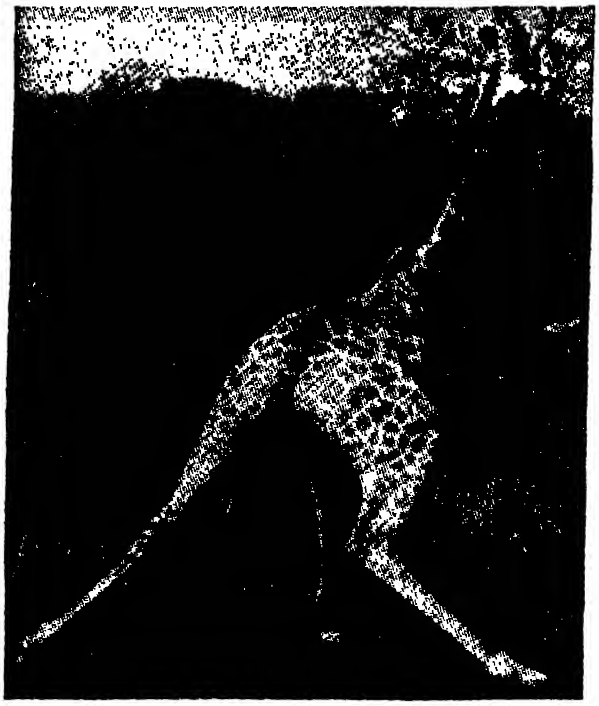
MEMORY TRANSFER PROSPECTS BRIGHTEN

Can learning and memory be transferred from one brain to another? The chances have improved with the isolation of what scientists call the memory or learning molecule in the brain of rats. Some think the molecule is a protein-RNA complex. However, more work on its isolation and purification is going on in several laboratories.

Studies in the field actually began a decade ago, based on nothing more than mere speculations. But soon it was discovered that in brain transfers, the recipient imitated the donor's behaviour and acquired the same habits, though a little slowly. Untrained rats went to light to receive water when brain from rats trained to do so was implanted in them. Such transfers, limited to one species till now, are now being extended to different species. What has created a keen interest in the studies is the isolation of memory molecules last year by Georges Ungar of Baylor University, Houston, USA, and Wolfgang Par of the University of Houston. They collected brain from rats trained to react to darkness. Then they tested it, bit by bit, for memory transfer in other rats and separated the part, a protein which they called 'scotophobin' (inducing fear of the dark), which was responsible for the actual transfer.

Others were quick to pick up the thread. Last November, two scientists reported success with scotophobin transfer from rats to fish. The fish did show fear of the dark, reacting intermittently, but the effect did not last long. Another researcher found that fish with transplanted brain promptly swam through a triangle to get food. This newly learnt habit lasted two days.

None has, however, ventured to draw any conclusions yet for want of more evidence. But many now tend to think that learned information can be transferred. Others believe that learning and memory are cellular or biochemical functions, and so need an intact brain; they can't be stored and transferred in separate packets. All, however, reserve judgments till results of more detailed studies are available.



A GIRAFFE FOR DIONYSUS?

Seen a giraffe getting drunk, and the graceful gait changing into a toddle? Or the bulky elephant swaying ponderously through the jungle? Comical? But they do happen, in southern Africa where the maroela berries grow. There the berry season is booze time for the animals. The berries are potent and ferment in the animals' stomachs. Drunkenness follows.

Baboons and elephants are particularly susceptible, says an article in *Science Digest*. But the sight is most ridiculous when it is the gentlemanly giraffe. One got so drunk that it forgot its way and toddled into a river till it sank helplessly neck-deep in the mud. After struggling for three hours, a team of cameramen, who had been following the drunkard to get a good shot, pulled the giraffe ashore.

SILICONE INJECTIONS HAZARDOUS

Silicone injections for larger breasts are hazardous, warns the American Medical Association. " The injection of silicone fluid to increase the size of the female breast is an unapproved surgical technique and is dangerous." Four deaths and many serious side-effects from such cosmetic use of silicone have been reported so far. The use of liquid silicone for filling out conspicuous sunken scarred areas, as on the face, injection into the eye for detached retina and into the larynx for certain malfunctions of the vocal cords, has, however, been approved by the US Foods and Drug Administration on a controlled trial basis.

WATER JET CLEANS WOUNDS

Borrowing an idea from dentistry, two orthopedic surgeons in Viet Nam have devised a pulsating water jet stream to clean debris from battle wounds. They find it more effective and less traumatic in cleansing tissue. It has been found three times more effective in removing steel filings and seven times more effective in washing out bacteria than a hand bulb syringe with a continuous jet of equal pressure.

" The basic premise is that in traumatic wounds there are both devitalised and contaminated tissue," explain Drs. Paul Stucker and Merlin Hamer. " The devitalised tissue must be debrided (cleansed). We are then faced with the contaminated tissue. In most wounds, this can also be debrided without sacrificing any function. This is rarely the case in hand wounds. With the pulsating water lavage we have successfully salvaged this living tissue and in addition have shortened the duration of hospitalisation."

RIGHT-LOOKER OR LEFT-LOOKER?

Whether you shift your eyes to the right or to the left when pondering an answer to a question is a clue to your personality. Prof. Paul Bakan, Michigan State University psychologist, says left-lookers are more sociable, musical and religious, tend to have more vivid imaginations, are more likely to be alcoholic, more susceptible to hypnosis and show greater fluency in writing.

Right-lookers score better on scholastic aptitude tests, sleep less, are more likely to major in science and mathematics. They also have more tics and twitches.

Prof. Bakan says most people look to the right or left (along with occasional up or down movements) about nine out of 10 times in replying to questions requiring reflection. "Preliminary observations suggest that asthma is more common among left-lookers. Headaches, especially migraine, are more common among right-lookers."

INSECT CONTROL WITHOUT TEARS

Scientists have been trying for some time to control insects and pests by genetic manipulation. Now a US scientist is studying possibilities of doing this with new, harmless chemicals. Unlike DDT, etc they do not affect human beings. The new chemicals are close to naturally occurring insect juvenile hormones that prevent insect reproduction and development. It is reported that the chemicals are effective against a broader spectrum of insect species than is the natural hormone. They can be used in stored grains and on crops.

WATCH OUT FOR THAT HARSH VOICE

A harsh, weak voice may indicate diabetes, say two US throat specialists. They found that a significant percentage of the diabetics they examined had either paralysis of the vocal cords, or paresis, in which movement of the vocal cords is severely limited. The doctors said the paralysis is probably linked to deterioration of nerves — known as neuropathy — which has been long associated with diabetes and is known to occur in some form in 50 per cent of all cases.

DON'T DROP THAT HAIR

Be warned. Your hair can give you away. A small piece of it can reveal your surroundings and what you have been eating, claims a US scientist. In a study sponsored by the US National Institute of General Medical Sciences, Dr. Willard W. Harrison of the University of Virginia found that excesses of all types of elements are stored in the hair. Using a spark source mass spectrometer, he identified minute traces of about 40 elements in the hair. But the amounts and proportions in each person's hair vary. And that is why it can be used as one of the clues in identifying a suspect. It can also be a useful tool in medical diagnosis. Too much or too little of certain elements in the hair may indicate certain deficiencies or malfunctions in the body.

In one case, Dr. Harrison found arsenic in the hair of a man who was ill. Enquiries revealed that his wife's previous husbands had died in a suspicious manner. Well, it eventually turned out that the woman had been poisoning her husband by mixing arsenic in his tea.

IMPROVED REFLECTORS

A Bombay firm has developed a reflex reflector for vehicles which can help prevent accidents in night driving, reports *Invention Intelligence*. The Motor Vehicles Act lays down a minimum reflecting capacity of 155 metres. But the new reflectors have a range of about 200 metres; they reflect light from the head lamp of a car at this distance. The reflectors are reported to have been tested by many State transport authorities and the Defence Department which has been so far using reflectors imported from Japan.

ON THE FARM FRONT . . . .

Hybrid maize growers in southern India have been facing a serious problem — their crops are under attack from two diseases, downy mildew and leaf blight. Growing resistant strains is one way of avoiding these diseases. But once the attack occurs, the Directorate of Extension, Union Ministry of Agriculture, suggests that the spraying of Dithane — 2·78 at 40 gm — or Cuman at 18 gm in 18 litres of water at 8 to 10 day intervals till the crop is 7 to 8 weeks old will control downy mildew. For leaf blight, after destroying all affected plants, 0·1 per cent Zineb or 0·2 per cent Zirum should be sprayed at 10–15 days, 20–25 days and 30–35 days of sowing the crop.

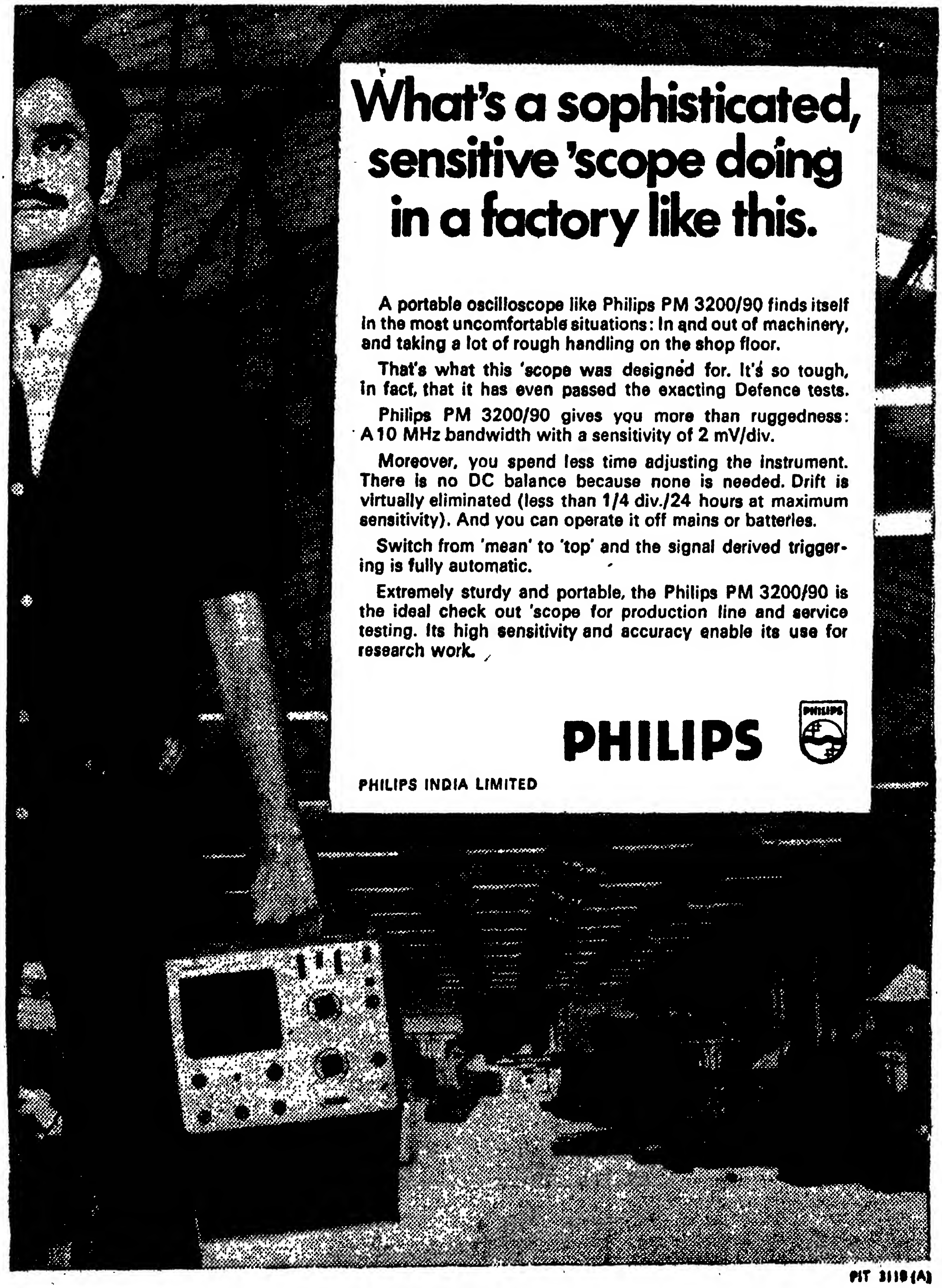
• • •

Oats are a better choice as a fodder crop in water-scarce areas where berseem or lucerne cannot grow, say scientists at the Indian Agricultural Research Institute, New Delhi. While consuming less water, oats also give more fodder. For good crops, 100 kg of nitrogen, 40 kg of phosphoric acid and 40 kg of potash per hectare may be used.

• • •

Agriculturists in western USA are farming in circles instead of the conventional rectangular farming. It is easier to water the circular farm with a centre pivot irrigator which carries and sprinkles water around from a plentiful ground water source. Of course, the irrigator is quite expensive (the minimum cost is Rs. 2 lakhs) but it has been reported to have brought good harvests in large farming where surface water is not available.

The system consists of jointed pieces of pipe, almost half a kilometre, mounted on wheeled A-frames. One end of the pipe is connected to a pump that forces water along the pipe and into hydraulically-driven cylinders that power the wheels to drive the rigs around the field like the hands of a clock. In some models, electricity or natural gas is used.


What's a sophisticated, sensitive 'scope doing in a factory like this.
A portable oscilloscope like Philips PM 3200/90 finds itself in the most uncomfortable situations: In and out of machinery, and taking a lot of rough handling on the shop floor.
That's what this 'scope was designed for. It's so tough, in fact, that it has even passed the exacting Defence tests.
Philips PM 3200/90 gives you more than ruggedness: A 10 MHz bandwidth with a sensitivity of 2 mV/div.
Moreover, you spend less time adjusting the instrument. There is no DC balance because none is needed. Drift is virtually eliminated (less than 1/4 div./24 hours at maximum sensitivity). And you can operate it off mains or batteries.
Switch from 'mean' to 'top' and the signal derived triggering is fully automatic.
Extremely sturdy and portable, the Philips PM 3200/90 is the ideal check out 'scope for production line and service testing. Its high sensitivity and accuracy enable its use for research work.
PHILIPS
PHILIPS INDIA LIMITED

PIT 3119 (A)

Is it possible for a breeder to cut out the cumbrous process of crossing and fertilisation? Haploids may be able to help him out...

PLANTS FROM POLLEN GRAINS

S. C. MAHESHWARI
SUDHIR K. SOPORY

PLANT and animal breeders of the future might be able to cut out much of the guesswork from their work by using haploids. These are breeding material having half the normal quota of chromosomes. A technique developed recently makes it possible to obtain haploid plants from treated pollen grains. Crossing or fertilisation is no more necessary.

Most biologists are understandably excited. Morphogeneticists never thought a gamete (sex cell) could develop into a whole organism without having to fuse with another gamete. Geneticists hope haploids will throw light on the genetics of higher organisms. Plant breeders see in haploids a short cut for breeding high-yielding crop varieties.

To understand why haploid plants have generated so much excitement, let's go over the facts of life. Almost all organisms are the result of sexual reproduction (Fig. 1). Our own lives started with the fusion of two gametes (male and female) which together constitute the only physical bridge between our parents and us.

These gametes contain chromosomes, rod-like bodies that carry the coded genetic information required to construct a complete organism. Before

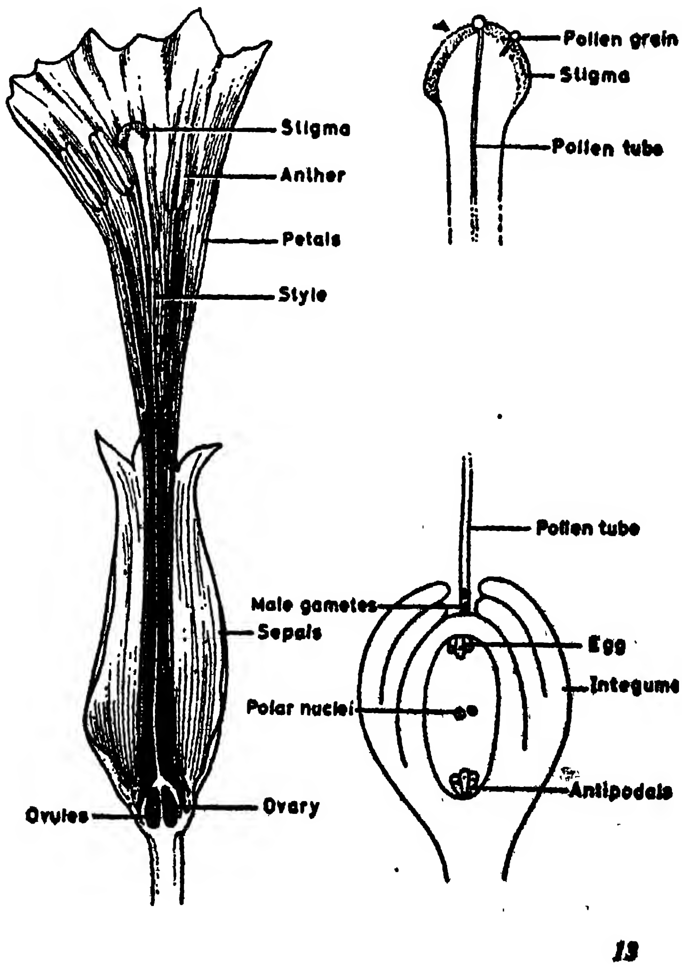


Fig. 1 At left are a flower and its parts. The anther and the ovary are the male and the female organs respectively. Diagram on the right shows how fertilisation occurs

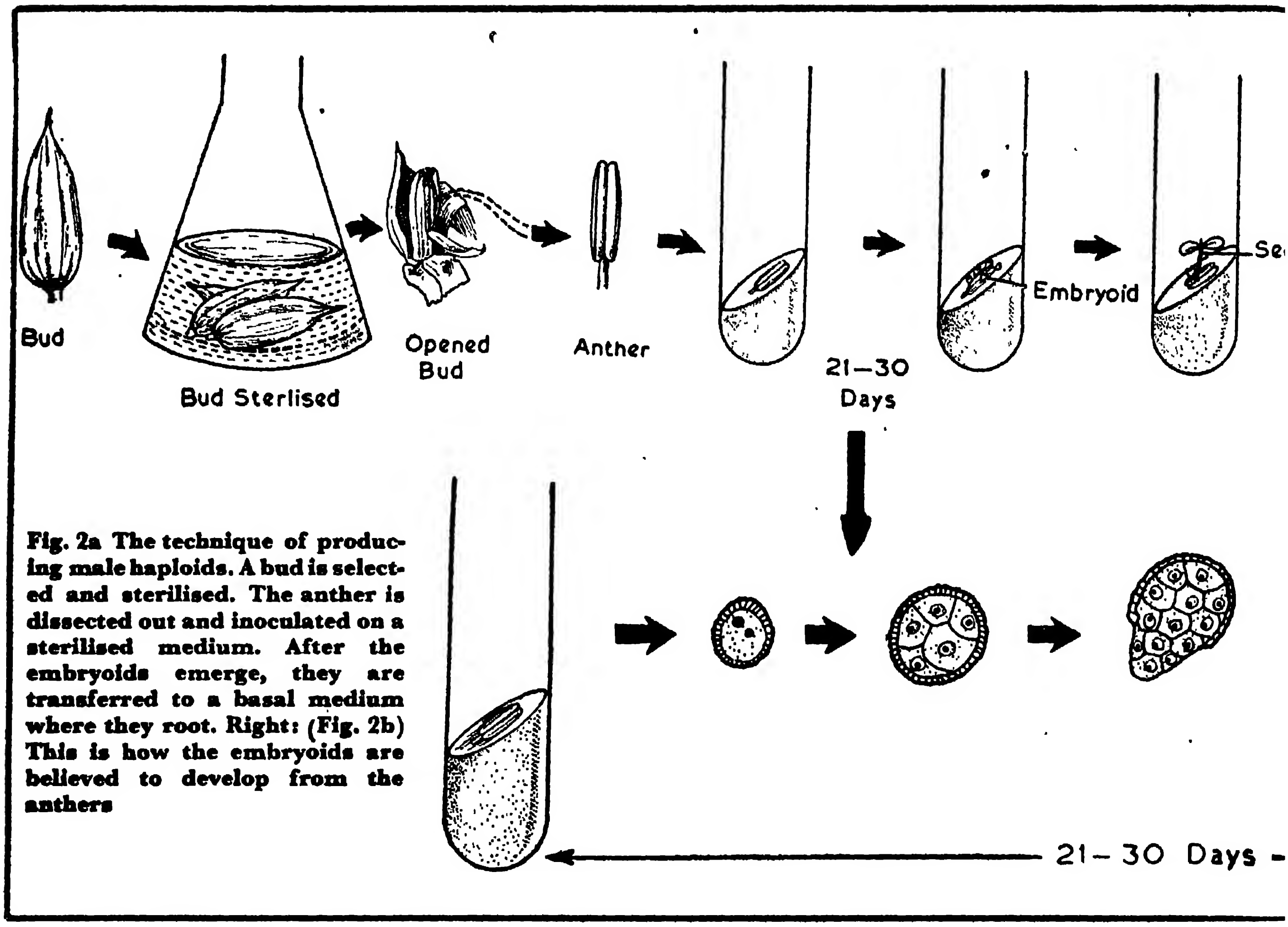
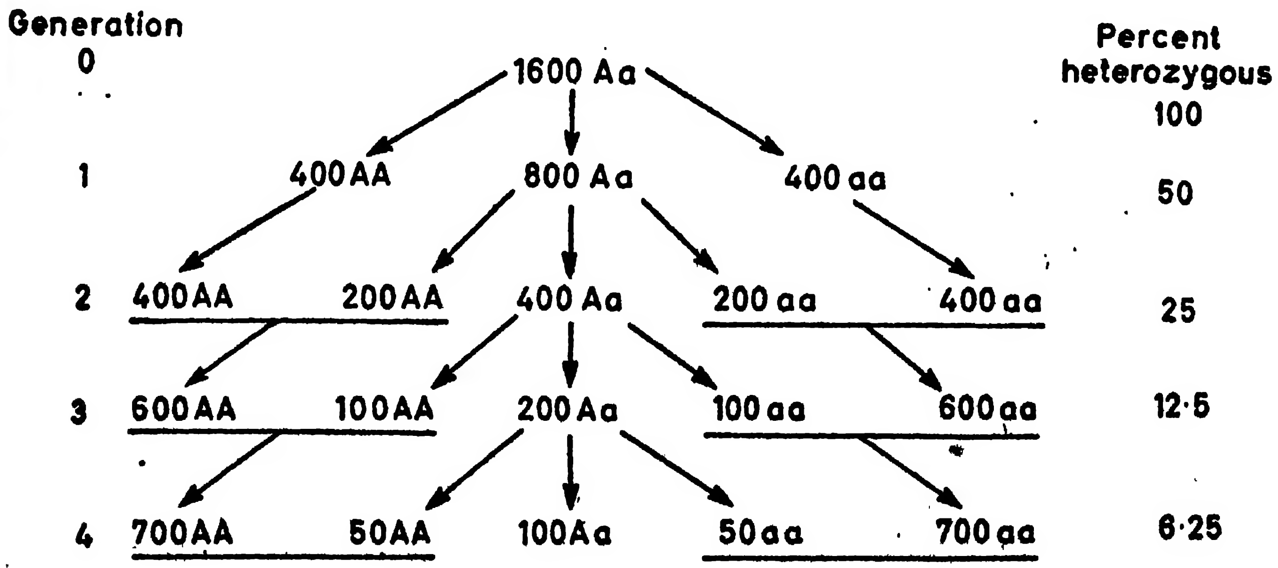


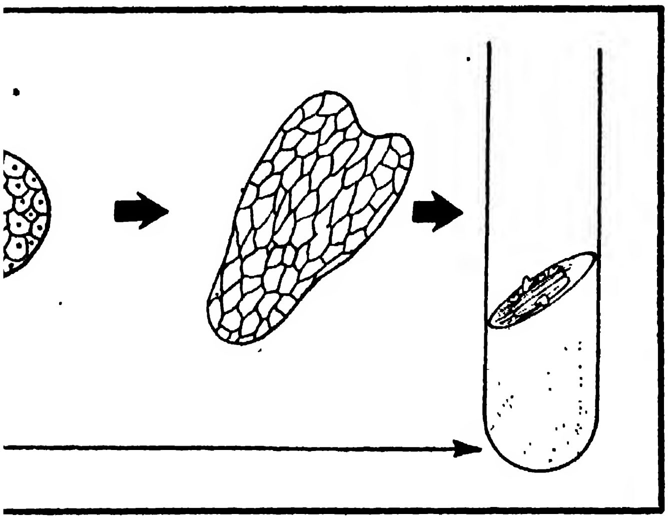
Fig. 2a The technique of producing male haploids. A bud is selected and sterilised. The anther is dissected out and inoculated on a sterilised medium. After the embryoids emerge, they are transferred to a basal medium where they root. Right: (Fig. 2b) This is how the embryoids are believed to develop from the anthers

Fig. 3 How homozygous (genetically pure) plants are raised at present — by the process of selfing



the gametes are formed, their chromosome number is reduced to one-half that of the parent by a process called meiosis or reduction division. This makes each gamete have only a single set of chromosomes. Upon the fusion of the gametes, the original chromosome number characteristic of the species is restored, the individual inheriting one set of chromosomes from its father and one from its mother.

Though sexual reproduction is of great advantage in that it enables shuffling and recombination of different kinds of genes and allows evolution to operate, it also is a great nuisance in agriculture. This is because, howsoever desirable a hybrid may



be and howsoever we may try to preserve its traits, it cannot breed true and is bound to throw up new and sometimes undesirable traits. On the other hand, what an agriculturist desires is a pure line, so that once a desirable plant is obtained it will continue to breed true ever after.

Selfing

The agriculturists obtain pure lines by " selfing " or inbreeding, a process requiring a great deal of patience and time and involving selection of desirable plants for several generations. With each successive generation the proportion of homozygous (genetically uniform) pure breeding individuals in the total population increases. But the process requires many years of careful work and even after 10 years the pure lines are not quite pure after all (Fig. 3).

What if a plant is made to develop directly from the pollen or egg and its chromosome number doubled with a drug such as colchicine, which allows chromosomes to divide (so that the cell has identical sets of chromosomes) but arrests their separation into daughter cells? We should then have an absolutely true breeding plant. That is why haploids hold so much promise in science.

There is another area where haploid plants can help genetics and plant breeding, and that is in producing mutants. It is the goal of every plant breeder to obtain new mutants so that new genotypes may be created and he might select a useful one. However, most mutations in the higher plants are recessive, and not until both genes (from the two parents) for a certain character are mutated (a very rare possibility) can the mutation be detected. If only one gene is mutated, it may still be masked because of the other dominant allele. With haploids, this difficulty is easily circumvented, there being only one set of genes to contend with. In short, what a plant breeder needs to do is to first raise haploids, then treat them with mutagens, (substances that produce mutations) select a mutant, double its chromosome number with colchicine and then release it for propagation.

Fig. 4 An anther showing the embryoids coming out of it, in a medium containing kinetin

Haploids in the Laboratory

Because of their great importance, many studies have been made to obtain haploids experimentally in large numbers. The earliest were attempts to induce the egg to develop. Blakeslee and his colleagues injected a dilute solution of the plant hormone naphthaleneacetic acid in the ovaries of unpollinated flowers of *Datura stramonium* — the same plant in which they had discovered natural haploids — but these and other similar experiments were failures. To coax the unfertilised egg to divide, other methods have also been tried, like pollination with X-rayed pollen (the idea being that such pollen may not bring about fertilisation but may yet release any chemicals necessary for stimulation of the egg). However, even these studies have been fruitless.

A prediction and its fulfilment

The idea that the pollen grain rather than the egg could be induced to develop into haploid plants was evidently not considered seriously until, by a strange coincidence, two events took place in 1964. Two Japanese scientists, Katayama and Nei, made the prediction in an article that "pollen culture if it becomes possible would become the most efficient method of raising haploids in large numbers". The same year, quite independently, (actually we were not aware of the paper of Katayama and Nei until after we had published our work) in our laboratory, we achieved production of embryos from cultured anthers of *Datura*. When in 1964 we reported embryos arising from anthers, we were not yet sure that they came from pollen but (in 1966) we showed by chromosome counts that they were haploid and did arise from pollen. Since then our work has been independently confirmed by other people and on other plants like tobacco and rice. We describe below these studies in the chronological order of their announcements.

1. *Datura:* The credit for the first report of the production of haploids goes actually to Dr. Sipra Guha who had begun post-doctoral work in this laboratory in 1963. Using anthers of *D. innoxia* and *D. stramonium*, the work had originally been planned to study factors that lead a cell to divide meiotically instead of mitotically. To do so, anthers were cultured in test tubes. Our work demanded experiments with very young anthers where the cells had not yet switched to reduction divisions. But, by accident, some older anthers containing pollen grains were also cultured and in these the presence of embryoids was noted in certain media. In the technique perfected by us later, the mature anthers plucked from the unopened flowers were sterilized and cultured aseptically — generally on Nitsch's basal medium consisting of major and minor salts plus vitamins, but occasionally Heller's and Torrey's media were also used. In several experiments, the medium was supplemented with one or more of the following: coconut milk, yeast extract, fruit juices, IAA, 2,4-D, kinetin and casein hydrolysate. The maximum percentage of embryoids was found in the basal medium supplemented with coconut milk or kinetin (a cell-division hormone in plants). The origin of the embryoids, which emerged from the dehisced portion of the anthers, as reported in *Nature*, was traced to the

Haploids in nature

Interest in haploid plants is by no means recent. Scientists have for long been looking for haploids. The first haploid, a stray one in nature, was discovered by the American geneticist Blakeslee and his colleagues about half a century ago in *Datura stramonium* — a weed common in almost all regions of the world. Plant explorations since then have revealed the existence of haploidy in about 70 species of flowering plants belonging to different families, but the frequency of occurrence of such plants is very low (about one or two in 10,000 plants).

In nature, haploids arise if, following sperm penetration in an egg, the male and female nuclei fail to

pollen grains (Guha and Maheshwari, 1966). Chromosome counts confirmed their haploid nature. The embryoids later developed into small plants.

2. Tobacco *(Nicotiana)*: Three years after the initial discovery of embryo formation by cultured anthers, Nakata and Tanaka (in Japan) and Nitsch and co-workers (in France) reported simultaneously the production of haploids from tobacco following techniques adopted by us in *Datura*. About twelve species of tobacco were studied, not all of which responded. Such haploid plantlets were later transferred to the soil where they flowered but did not set seeds — unless the chromosome number per cell was doubled by colchicine.

These reports on *Nicotiana* were further confirmed by Sunderland and Wicks at the John Innes Institute in England. Indeed, so refined are the techniques now that haploid plants can now be raised in hundreds in the European, Japanese, and American laboratories. This contrasts with our early work on *Datura* when we struggled to keep a few plants alive upon their transfer to the soil from the test-tubes.

3. Rice *(Oryza)*. This is the first and the only monocotyledon so far found capable of producing haploids. The report immediately followed that of tobacco. Niizeki and Oono (1968) could obtain haploids in Blaydes medium supplemented with IAA, kinetin and 2, 4-D. This work was confirmed and extended by Dr. Sipra Guha and colleagues (1970) in Dr. M. S. Swaminathan's laboratory at the IARI, New Delhi. Unlike *Datura* and tobacco, here the development is through a callus — an unorganised mass of cells — which differentiates on IAA and kinetin medium. — S.C.M. & S.K.S.

fuse and if development of the egg proceeds with a nucleus containing only one set of chromosomes. If the latter is male, the development is known as 'androgenesis' (*andro* = male) and if female 'gynogenesis' (*gyno* = female). Instances of both androgenesis and gynogenesis have been known in plants. In most cases the evidence of such a course of development is genetical — when the offspring shows the characters of either only the male or the female parent — but in some instances these conclusions have been confirmed by microscopic studies as well, where one of the two nuclei has been found to degenerate and the egg cell has produced an embryo without fertilisation.

One of the earliest analysed cases of an androgenetic haploid was in tobacco. Kostoff, a Hungarian botanist (1929) pollinated a triploid *Nicotiana tabacum* var. *macrophylla* with *N. langsdorffi* and obtained a single hybrid plant which showed no *N. tabacum* features at all and was haploid. The first analysed case of gynogenesis was that by Jorgensen (1928), a Swedish botanist who pollinated *Solanum nigrum* with pollen of *S. luteum*. The pollen grain germinated; the sperm was even discharged into the egg, but it degenerated soon after. Nevertheless, the entry of the sperm stimulated the egg sufficiently to divide and form a few haploid plants.

Steps in androgenesis

The whole process of androgenesis is not as simple as it may seem and takes about a month. We summarize the steps below:

What we do (Fig. 2a)

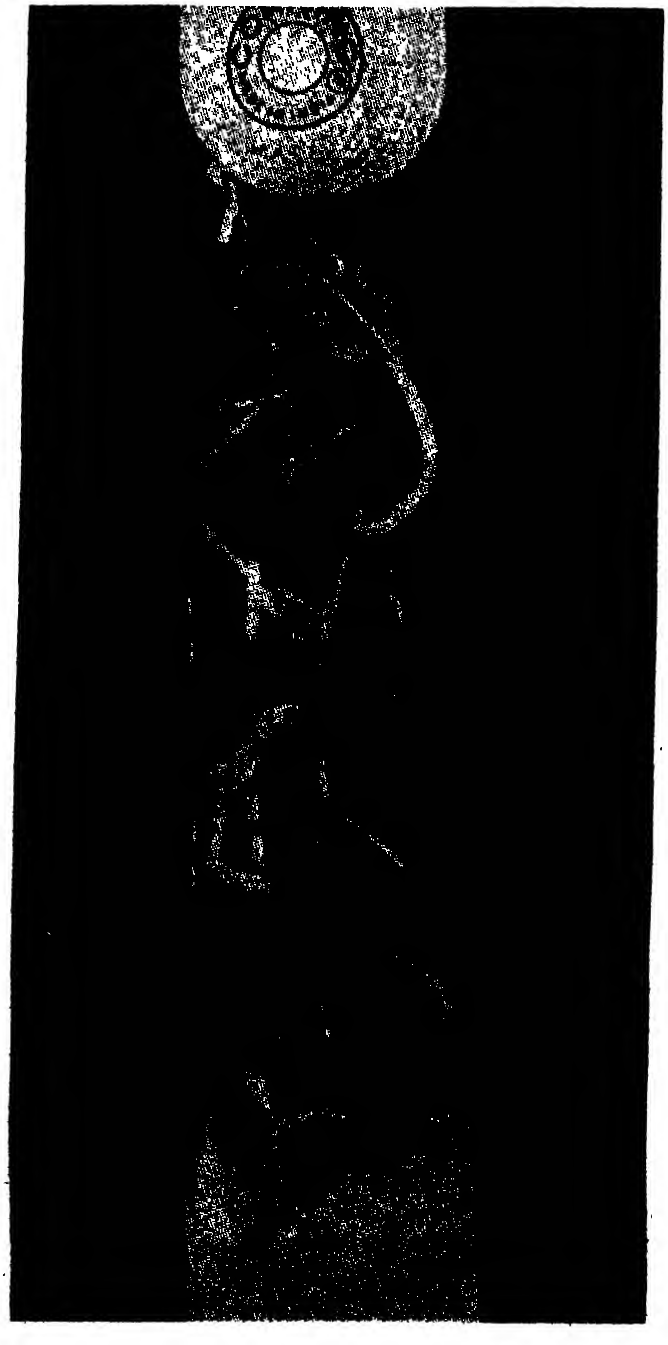
1. Select the right bud.
2. Sterilise it with a suitable sterilising agent such as calcium hypochlorite.
3. Dissect out the anther from the bud.
4. Inoculate it aseptically on a suitable medium, sterilised previously, and wait for about three weeks. After 21–30 days, the embryoids come up (Fig. 4).
5. Transfer embryoids to basal medium where they root (Fig. 5).
6. Transfer to soil and
7. Finally, observe the plants in bloom; for raising homozygous plants the young plants may be treated with colchicine.

What happens in the anthers (Fig. 2b)

1. After planting, anthers might enlarge a little or turn slightly brown.
2. Pollen grains inside start growing — in some media with which we are experimenting as many as 20 per cent of the pollen grains start dividing. (The total number of pollen grains per anther may be as high as 20,000).

3. Growing pollen grains divide into 2, 4, 6 and 8 and then into a group of cells.
4. The group of cells is released from the wall which forms the pollen grain.
5. The cells form an embryo which comes out of the anther from the line of dehiscence. The latter grows and starts forming cotyledons.

Fig. 5 A haploid plantule developed from an embryoid upon transfer to the basal medium



This way, you will agree, the haploid follows the same course as a normal fertilised egg. The above, of course, is only an outline of androgenesis; we are far from certain about all that happens in the anthers. The mature pollen grain in most plants is not really unicellular or uninucleate, but two or three-celled. The original nucleus divides to form a larger vegetative nucleus and a smaller generative nucleus (separated by a membrane). The pollen grains may be shed from the anther at this stage or the generative cell may already divide to form the two sperms cells. The point is, at what stage must the anthers be inoculated, and whether all these cells take part in the formation of the pollen embryo or only one or two? In tobacco, it appears that only the one-celled immature pollen grain is capable of producing the embryo, but in other plants like *Datura* where anthers containing binucleate pollen grains also appear to produce the embryos, the situation seems very complicated. These are details that remain to be worked out.

The future

This in short is the story of androgenic haploids. Obviously much remains to be done. An agriculturist cannot be satisfied with *Datura*, tobacco or rice only — he should be able to raise haploids in any species of plant he wishes. Further, the haploids also seem to hold out great promise in the study of the genetics of higher plants. Will the technique be useful only in those plants where haploids occur in nature, or will it be possible to produce haploids in other plants too? This is a question whose answer we would like to know. Besides, we are interested in determining how precisely the androgenic development takes place — whether a particular step is controlled by a particular factor(s), and what are the chemicals which make pollen 'forget' its normal course of development and divert it in a new direction? So, our quest continues in the laboratories of this university, the IARI, and many other institutions of the world.

So far, the technique of growing haploid embryos has been put to use by plant scientists only. But similar work is now being attempted on animals. Last year, reports appeared from Edwards' laboratory in Cambridge that haploid mice could be got from egg cells by activating them with sperms, without actual fertilisation. Probably the day is not far off when the same feat would be possible with human sperms and ova. We can only imagine the consequences of such research work which may enable human embryos to be grown in test tubes not only from fertilised ova, but even from sperms or just eggs!

Crick Cracks Chromosomes

HOW is DNA, the genetic material of all living organisms packed in the chromosomes of higher forms of life? Dr. Francis Crick who, together with Dr. James Watson and Dr. Maurice Wilkins, won the Nobel Prize for Medicine and Physiology in 1962 for elucidating the structure of DNA has now, in an article in *Nature* (*234*, 25, 5 November 1971), proposed a general model for the structure of the chromosomes of higher organisms. The model is not truly his own, but derived from ideas and data from many sources.

In simple organisms like bacteria, DNA alone provides the genetic apparatus. But the chromosomes of more complex organisms contain not only DNA but have definite structures containing other components such as proteins. According to Dr. Crick, the manifestation of his model is seen in the chromosomes of the salivary glands of *Diptera* where, under the microscope, one can see large bands alternating with much smaller interbands. The model assumes that the DNA within the chromosomes is one long molecule which probably runs continuously from one end to the other.

The model suggests that chromosomal DNA falls in two classes. Only a small part of the DNA actually carries information for the synthesis of proteins. For convenience he calls the DNA sequences coding for proteins ' fibrous DNA' and postulates that this class of DNA is contained mainly, if not entirely, in the interbands. The segments of fibrous DNA are in the form of a double helix, which is the usual DNA structure, in the environment of the cell. These regions, when active, direct the synthesis of proteins by forming the usual intermediate known as mRNA.

The bands, according to the model, contain almost all of the rest of DNA referred to as "globular DNA". According to the Nobel Prize winner, globular DNA is mainly concerned with controlling the activity of fibrous DNA. The globular DNA contains not only DNA in the usual double helix form, but unwinds into its two component strands. These unwound strands, Dr. Crick states, are needed for recognition by regulator molecules. This recognition dictates the activity of the adjacent segments of fibrous DNA. The nature of the regulator molecules which must interact with the control elements of DNA is unknown, but if they are RNAs, it makes obvious sense for recognition sites to be single-stranded regions of DNA with which complementary base pairing can take place. Further, Dr. Crick argues, for all proteins whose tertiary structure is known, the active site, to a first approximation, is a cavity rather than a protuberance and it would be easier for protein regulators to recognise specific sequences of single-stranded nucleic acids.

To unwind DNA, of course, needs energy and Dr. Crick suggests that this energy is probably provided by some of the protein components which help to build the structure of chromosomes. He names the histones as most likely candidates for this job. In his view, the role of histones is not merely to cover up the DNA but also to help the DNA to expose itself in the right places.

One of the most awkward facts to account for, when analysing the heredity of higher organisms, is their great excess of DNA; the amount varies with the species but there always seems to be much more than is needed to code for all the various proteins to be made. According to Dr. Crick and others, on whose models the present article is based, the reason for this discrepancy is that very precise multiple control elements may well be needed adjacent to each particular coding sequence. This is probably the reason why the bands (control elements) are so large compared with the interbands (coding elements).

Dr. Crick concludes that his model which is logically coherent appears to be compatible with a very large amount of experimental data obtained using different techniques. These include rough estimates from genetic data for the number of genes in *Drosophila* and man, the correlation between the number of bands and interbands, as also the electron microscope pictures and measurements of chromosomes.

Jaundice and Oral Contraceptives

THE contraceptive pill may be the cause for a form of jaundice affecting babies in the first few days of life. This is the conclusion of two British doctors, Dr. Y. K. Wong and Dr. B. S. B. Wood, belonging to the Special Care Baby Unit of the Birmingham Maternity Hospital, UK, from a study of breast-fed infants.

Many babies are mildly jaundiced for a week or so after birth. The condition is usually regarded as normal because at birth the liver is not fully developed and cannot cope with the load of the pigment, bilirubin, released from the breakdown of haemoglobin. A relation between jaundice in newborn babies and breast-feeding was first recorded in 1963. Since then, several reports have appeared indicating

that there is a higher incidence of jaundice in breast-fed than in bottle-fed infants, and that in many cases, the jaundice disappeared if the baby was put on bottle-feeding. Although no reason could be assigned then for this effect of human milk, the condition is now known as " breast-milk jaundice ".

In an article in the *British Medical Journal* (*4*, 403, 13 November 1971), Drs. Wong and Wood report, from a study of breast-milk jaundice, that mothers of babies with this disease frequently used contraceptive pills before becoming pregnant. Their study is based on 116 breast-fed infants selected at random from postnatal wards. Infants of low birth weight, sick infants, infants of mothers with any clinical infection or diabetes metillus were removed from their study. Moreover, mothers who had received oestrogen-progesterone preparations other than the pill or had had the pill for less than one full course were also excluded from the study, along with their infants.

Infants who had never been jaundiced or whose jaundice was slight and already fading by the fifth day of life were classified as non-jaundiced, whereas infants whose bilirubin levels in the blood were 10 mg per 100 cc or more on their fifth day was classified as jaundiced infants. Infants whose bilirubin levels were greater than 15 mg per 100 cc on their fifth or subsequent days of life were classified as severely jaundiced.

Their results showed that out of the 116 infants, 69 were non-jaundiced and 47 jaundiced. Of the 69 non-jaundiced infants, 24 (34·8 per cent) mothers had been on the pill and of the 47 jaundiced infants 33 (70·2 per cent) mothers had been on the pill. Further, of the 18 severely jaundiced infants 14 (77·8 per cent) mothers used the pill. Their study thus strongly suggests that there is a close relationship between the pill and idiopathic jaundice in the breast-fed infants.

While they offer no explanation for this apparent connection between oral contraceptives and jaundice, the British doctors conclude that it should be noted that the oral contraceptive pill came into increasingly widespread use in the US from 1958 and in the UK from 1960 onwards, and that breast-milk jaundice was first recorded in 1963.

Did Oil Help the Origin of Life?

**AN oil slick, 1 to 10 metres thick, covering the entire surface of the Earth in the early part of its history, might have played an important part in the prebiological and early biological development of our planet. This is the conclusion from some calculations and experiments conducted by two geophysicists, Drs. A. C. Lasaga and H. D. Holland, of the Department of Geological and Geophysical Sciences at Princeton University, USA, in collaboration with a molecular biologist, Dr. M. J. Dwyer, working at the Graduate Group on Molecular Biology, University of Pennsylvania, Philadelphia, USA. The calculations as well as the experiments are described in an article in *Science* (*174*, 53, 1 October 1971).

Well-established theories on the origin of life suggest that life originated on Earth from a primordial organic soup in its oceans, as a result of lightning discharges in the atmosphere as well as the action of ultraviolet radiation from the Sun. Numerous laboratory experiments have confirmed that the ideas in these theories may be correct by showing that amino-acids and a large variety of the other building blocks of living organisms can be synthesised in electrical discharges if free oxygen is absent and if some reducing gases like methane are present.

The American scientists assume in their calculations that the early terrestrial atmosphere, besides having methane and nitrogen, as its major components probably contained small traces of water vapour, hydrogen, carbon monoxide and ammonia. This mixture forms the atmospheres of the giant planets in our solar system today. Such an atmosphere would have responded to solar ultraviolet radiation and to lightning discharges quite differently from our present atmosphere. In the present report, their calculations are confined to the effects of solar ultraviolet radiation.

The scientists further assumed that the short wavelength ultraviolet radiation from the Sun would be primarily absorbed by methane at an elevation of 100 to 300 km. In the predominantly methane-nitrogen atmosphere, methyl and methylene radicals will be produced, which will then combine to form heavier hydrocarbons like butane, hexane, etc. Their computations indicate that the process of hydrocarbon build-up must have been very rapid. Transport processes would have carried these hydrocarbons to the lower atmosphere, and ultimately condensation near ground level probably led to the development of an oil slick. According to them, the methane atmosphere would have been polymerised by solar ultraviolet radiation within 10 million years, a very short time in the history of the Earth. If one atmosphere of methane is polymerised, a universal oil slick some 1 to 10m thick would result.

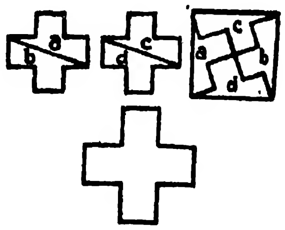
To test the results of their calculations, Dr. Lasaga and his colleagues irradiated methane at a pressure

(Contd. on next page)

BRAIN TEASERS

A cutting question

THE top line of the diagram shows what many consider to be one of the most elegant dissections in the whole realm of problemdom — two Greek crosses cut into a total of four pieces which will jigsaw together to form a perfect square.

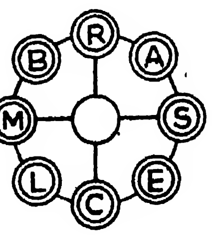


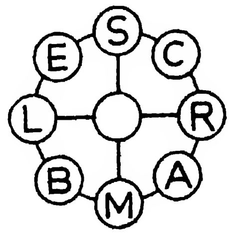
Below this example is a somewhat bigger single Greek cross. Can you discover how to cut this single cross into four pieces which will likewise fit together to form a square?

It is not an easy problem but may be the top diagram will suggest some line of attack.

Let's scramble

Scrambling things is easy, but can you unscramble a scramble? Place eight lettered counters or paper discs on the (left) diagram in the order shown here:





The idea is now to move the discs one at a time, from circle to circle along the lines of the diagram until, starting from the top and reading clockwise, it is possible to read the word SCRAMBLE as shown in the next picture.

The first move must obviously be one of the four letters R, M, S, or C to the vacant circle in the middle, followed by B, A, L, or E into the circle just vacated, and so on.

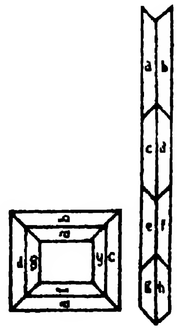
What is the smallest number of moves needed to unscramble the scramble?

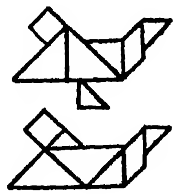
Xeno

(Solutions next month)

Solutions to last Month's Brain Teasers

The pieces in the two figures are arranged thus:





(Continued from facing page)

Round-up of Research . . .

of 5 mm of mercury in a long glass container. The source was high-intensity, short-wavelength ultraviolet light produced in a plasma torch. The irradiation products were collected in both gas expansion bulbs and by nitrogen cold trap, and analysed by gas chromatography several times during a 42-hour irradiation. The results indicated that the products formed were heavier hydrocarbons and a steady state was reached within the first few hours of irradiation, consistent with the results of their calculations.

An oil slick covering the entire ocean surface would have had some rather intriguing consequences. The dilute prebiotic soup would have been covered with a very rich hydrocarbon layer. The mixture then could have been exposed to longer wavelength, solar ultraviolet light and lightning discharges, as well as to solvent extraction processes at the water-oil interfaces. This could have profoundly affected the development of organic molecules, encouraging the formation of compounds essential to life as we know it today.

K. A. Neelakantan

BLURS & BRIGHT SPOTS

NATAPROBU? Nothing doing...!

THE acronym is more for self-respect. It stands for the National Association of Professional Bureaucrats and is devoted to paper-shufflers everywhere " who by their steadfast dedication to the principles of dynamic inactivism, have kept things from happening, and thereby prevented mistakes from being made ". We were of course quite unaware of this unique Washington institution until we saw a recent issue of the *Wall Street Journal.*

The high priest of NATAPROBU is James Boren, a former US State Department official and now a Washington consultant, who is sworn to the ideal of according to ' creative bureaucracy ' its rightful recognition and rank in human affairs. (Don't frown on the word ' creative '. Bureaucracy does create inactivity!) And Boren's frequent advice could pass for its motto: " When in charge, ponder. When in trouble, delegate. When in doubt, mumble. Then refer it to a committee for review."

NATAPROBU was started in 1968. But after barely three years of ' nothing happening ', things have started happening. Boren is worried. " It's a contradiction of the original commitment ", he says.

Of course, nothing would have happened but for the " Order of the Bird ". This is an award, a metal statue of an " unfeathered, pot-bellied bird ", presented by NATAPROBU to those " who exhibit excellence in bureaucratic excess ". The first winner was an US Internal Revenue official for his beautiful, lengthy memorandum on the length and look of employees' sideburns. But things are looking bad. No one wants to get the bird. Not even Spiro Agnew, the US Vice-President who was nominated winner at NATAPROBU's 1969 awards banquet (red tape delayed it to December 1970) for his " alliterative achievements in communications". Mr. Agnew declined the honour. In fact, bureaucrats have found a way of getting even with Boren. As soon as a nomination is made, they not only decline the award but embarrass the NATAPROBU founder by letting a job get done quickly. Take, for instance, the case of a handicapped Korean War veteran. The Social Security Administration cited regulations to deny him a total-disability rating even though he had suffered a third heart attack. When Boren heard about it, he sent a press release nominating the officials involved for the Order of the Bird, " in recognition of constant devotion to punctilious and amblyopic interpretation of Social Security rules ". But the officials fought shy of personal recognition and granted the veteran the rating after all.

Or, take the case of the Denver inventor. Early this year, the Federal Aviation Administration threatened to fine him for failure to get FAA clearance before flying his tethered, home-made helicopter six inches off the ground. But when Boren wired congratulations and a nomination (also released to the Press), the local FAA office passed the buck to Washington, who bucked it back, and it dropped the case.

Then last summer the US Congress decided to hear him. Boren was a star witness at a hearing by a House Public Works Subcommittee into ways to reduce government red tape. Boren was eloquent in his opposition: " To deny a dedicated fingertapper an adequate supply of paper on which to record the results of his prodigious ponderings is to deny him the tools of creative nonresponsiveness ". If you wish to control government bureaucracy, Boren suggested, create another bureaucracy. It could be called the Department of Adjusted Procedures and Orchestrated Clearances, or DAPOC. There could also be sub-agencies like Office of Orderly Overruns, Permeations and Statistics (OOOPS) and Governmental Linguistic Obtusity Bureau (GLOB).

NATAPROBU has 500 members now. If you wished to join, you could, provided you paid the $10 membership fee. All new members get a special kit: it includes a bureaucrat's pencil with erasers at both ends.

Or, better still, we could do with a Jim Boren in India itself.

R. BUCKMINSTER FULLER

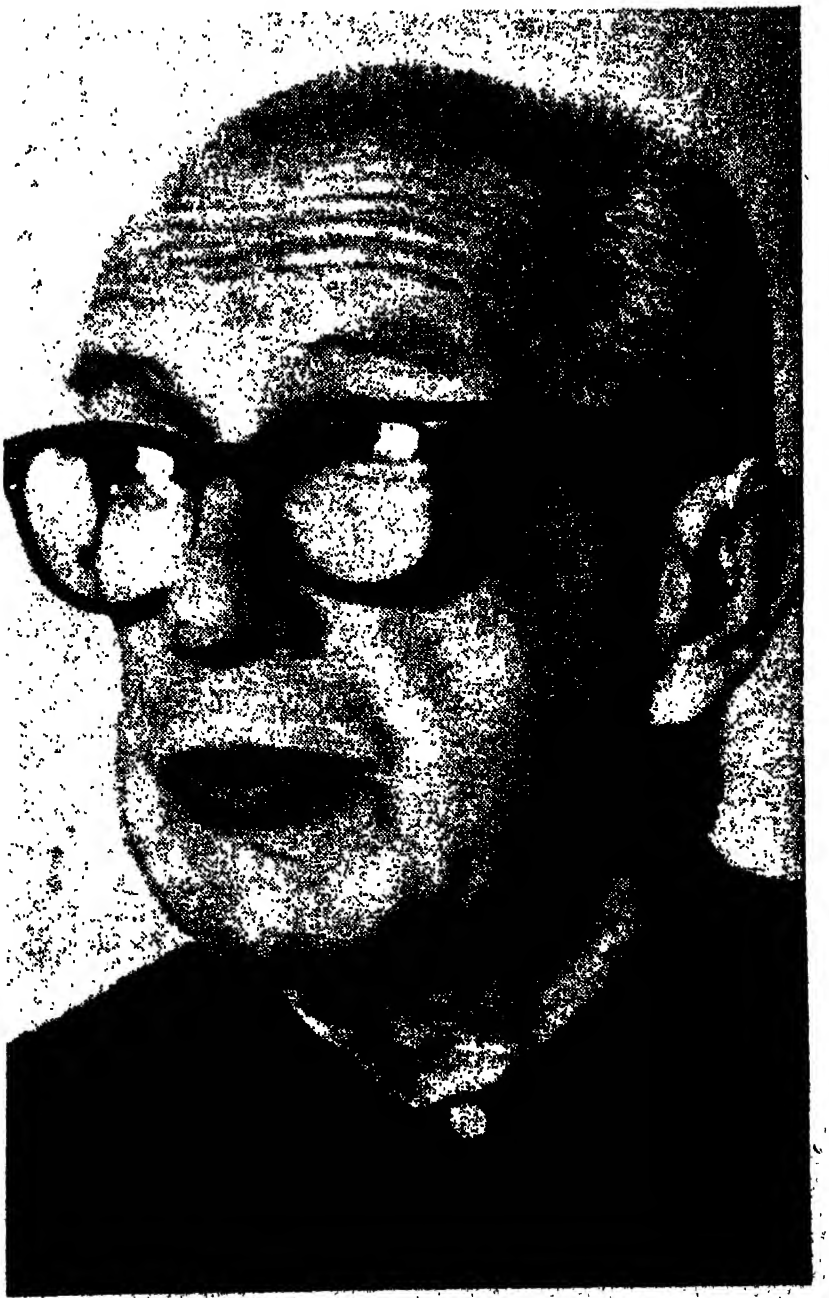
Designer of the Future

an interview

HE has been called many things — engineer, inventor, mathematician, architect, cartographer, philosopher, poet, cosmogonist and comprehensive designer. He has been called a visionary. He had also been called — though many years back — the lunatic of domes and globes. Today the scale weighs heavy with adulation — all of it placed on deserving shoulders. Fuller had taken a lot of beating from life, but didn't give up and in the end the world realised here was one man who had found a way of making humanity happy by " doing more with less ".

He is a great talker. People say he is the world's most listenable monologuist. He is also a globe-trotter. It is preposterous to ask him where he lives. Man was born with legs, he says, not roots, and mobility is his primary natural advantage. Although his official home is in Carbondale, Illinois, USA where he is a professor of Southern Illinois University (he calls his field " Design Science "), he hardly spends more than two months there; the rest of the time, if you wish to find him, you must check with the airports of all the cities in the world. His age is 76, though.

He was born in Milton, Massachusetts in 1895. It was at Milton Academy where he went to school — in fact, it was in the mathematics class — that he began to question what he was being taught. This is how he described it in a published interview 5 years back: " The teacher made a point on the blackboard, then erased it and said, ' That doesn't exist.' She made a row of points, and said, ' That's a line, and it doesn't exist either.' She made a number of parallel lines and put them together to form a plane, and said it didn't exist. And then she stacked the planes one on top of the other, so that they made a cube, and she said that existed. I wondered how you could get existence out of nonexistence to the third power. It seemed



unreasonable. So I asked her, ' How old is it? ' The teacher said I was just being facetious. I asked her what it weighed and I asked how hot it was, and she got angry. The cube just didn't have anything that I thought was existence, but I thought I was probably being unfriendly, and so I shut up. I got A's in all my science work, and when I got to Harvard I didn't go on with mathematics, because it was so easy — just a sort of game you played. I thought I'd take something really difficult, like government or English.

" I was kicked out of Harvard. I spent my whole year's allowance in one week, and I cut classes and went out quite deliberately to get into trouble, and so naturally I got kicked out. I was sent to work in a factory in Canada making cotton-mill machinery, and I did very well there. It was a very important phase of my life, for I met shop foremen and machinists, and got to know a lot about their tools and about metals in general. I did so well that Harvard decided I was really a good boy and took me back the following year, but obviously I couldn't stay at Harvard very long. (In his autobiography, Fuller wrote that what really bothered him at Harvard was the social institutions.) So I cut classes and got fired again. This time, I enlisted in the Navy, where again I began to do very well. Well, one day in 1917 I was standing on the deck of my ship looking back at the wake — it was all white because of the bubbles — and I began wondering idly how many bubbles there were back there. Millions, obviously. I'd learned at school that in order to make a sphere, which is what a bubble is, you employ pi, and I'd also learned that pi is an irrational number. To how many places, I wondered, did frustrated nature factor pi? And I reached the decision right at that moment that nature didn't use pi. I said to myself, ' I think nature has a different system, and it must be some sort of arithmetical-geometrical coordinate system, because nature has all kinds of models.' It struck me that nature's system must be a real beauty, because in chemistry we find that the associations are always in beautiful whole numbers to make all her basic structures, I thought, then the system will turn out to be a coordinate system and it will be very, very simple. And I decided then, in 1917, that what I'd like to do was to find nature's geometry."

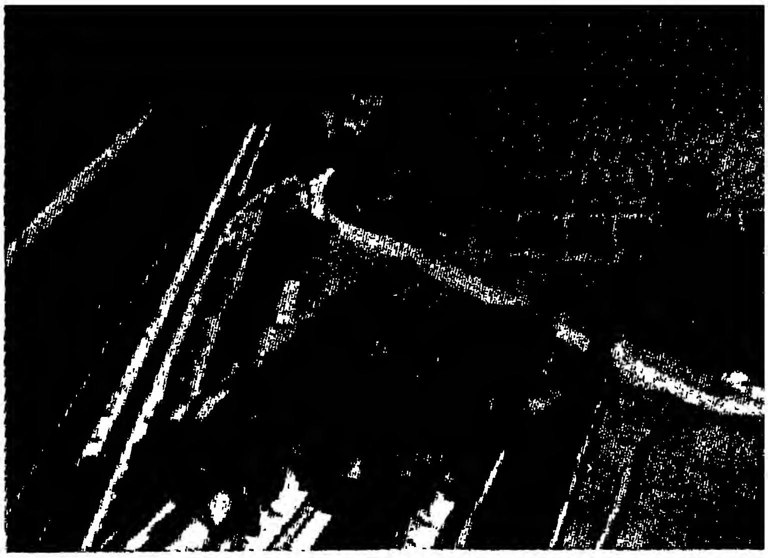
Instead of using the ' non-existent ' points and lines and planes, Fuller started with vectors, or lines of force. And he fell in love with vectors. Vectors were descriptions of actual physical events — energy events — and they were discrete. This new geometry was discrete geometry. And this led Fuller to the conclusion that nature's geometry was based on triangles. " The triangle is a set of three energy events getting into critical proximity, so that each one with minimum effort, stabilises the opposite angle." A quadrilateral, a square, will not hold its shape. No polygon can do it either, unless it was based on a triangle. How many triangles would be needed to make a system that had an inside and an outside? Not two, for they would fall back on each other and become congruent. You need three triangles, with three common sides, around a point and they formed a fourth triangle at the base and you get a tetrahedron. This was the simplest shape in nature — it was the fundamental shape. All other shapes are only transformable states of the tetrahedron.

1927 was the critical year in Fuller's life. He was at the lowest point in his career. For several years after he resigned from the US Navy, in 1919, he had done quite well. He had worked as assistant export manager for Armour & Co., and in partnership with his father-in-law had formed a company to exploit a building-block method of construction. In 1922, his young daughter died, and Fuller turned to the bottle. Yet he kept on working. But in 1927, his father-in-law was obliged to sell his stock in the company and the new owners dismissed Fuller. It was a big blow, shortly after his second daughter Allegra was born. Fuller contemplated suicide: This would give his wife and new baby a chance to "find someone better equipped to take care of them". But he had to take the harder way out — " devote the rest of his life to the service of something greater than he was". He said to himself: " You do not have the right to eliminate yourself, you do not belong to you. You belong to the universe."

Fuller moved to a slum neighbourhood in Chicago and started thinking for himself. He had learnt a lot during his years at the Navy — it taught him the future of technology and how man could do " more with less". If man could do that, he could turn Malthus and Darwin's dark prophesies upside down. His first major invention was the Dymaxion House in 1929. It was a circular dwelling house suspended by cables from a central mast — built after the discovery that the tensile strength of certain metals and alloys is far greater than the strength of the same materials when used in compression. (The term Dymaxion — a portmanteau

. . . The universe is designed — a continuously changing design — so that man has continuing change in his own capability. What is happening now is to accommodate various challenges of environment. My definition of environment is " to each human being the environment is everything that is not me ". And environment is not just the walls; it is all the people, all the ways the Sun is shining and not shining. All that is environment. . .

Fuller (right) posing before his Dymaxion Car in 1935



The huge geodesic dome built in 1958 that houses the car-shed of the Union Tank Car Company in Baton Rouge

. . . My vocabulary is very carefully picked. I have gradually disciplined myself to be careful about every word. Whenever I publish anything, I rewrite it at least 7 to 10 times till I get every word I'm sure is the right one. I am not using any words because they are customary words, I must be absolutely discrete and most economical . . .

of ' dynamic ', ' maximum ' and ' ion ' was coined by a publicity man for Marshall Field's, the Chicago department store, where the house was first exhibited.) His Dymaxion Car (3 prototypes were built between 1933 and 1935) could turn in its own length and go at a speed of 120 mph with a standard engine. Then in 1943 he published his Dymaxion World Map (the first cartographic system to get a US patent). In 1944, the US government agreed to release high-priority aluminium alloys for Fuller's Wichita House, a new version of the Dymaxion House. It was expected to be a giant leap towards solving the housing problem, but then the war ended and the building industry decided the old-fashioned way was the safest way.

In 1947, Fuller came out with his famous geodesic domes. For some time, all geodesic domes were built by two companies set up by him, Synergetics, Inc., and Geodesics, Inc. Now 200 construction and other firms are licensed to do it. Today, his domes are spread all over the world — some 3,000 of them — ranging from small living units to large maintenance and repair sheds including the 384-feet-diameter shed put up in 1958 for the Union Tank Car Company in Baton Rouge. His geodesic Radomes house the US Air Force's Distant Early Warning Line in the Arctics. In Equatorial Africa, he has taught the natives to make them out of bamboo. The US Marine Corps uses air-liftable geodesic domes as its advance-base shelters and since 1956, Fuller's domes house most of the American exhibits in international fairs. In 1969 he was invited to deliver the third Jawaharlal Nehru Memorial Lecture in New Delhi. He is now " toing and froing " to India to build three super-airports which will handle the future SSTs. It was during his last visit, that we talked to him about his vision of our world and our civilisation. He has high hopes for India's future for what he calls our " emphasis of the mind over matter ".

●●

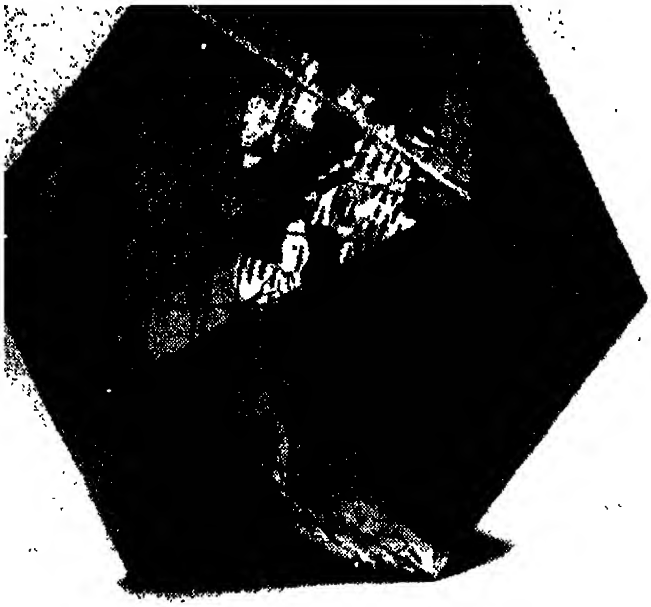
Among the thousands of admirers and Fuller-watchers, one can count a few hundred of his students too — men and women who had come from all over the world to learn the Dymaxion science. PRAVINA MEHTA, a designer and architect-planner in her own right, was his student once and it would be appropriate, we thought, that she should lead this interview with one of the great minds of our time. Pravina began the interview with a tribute :

Bucky, he is a phenomenon. He has been introduced as designer, architect, inventor, philosopher. I think he is all that, but I think he is above all a phenomenon. I have watched his movements, his ideas, his thoughts for last 25 *years. I met him in* 1949-50. *I see him now holding the world in his hands — he is describing the world scene — and he is like our* **sutradhara** *— the person who introduced and explained the drama — that is what he is doing, he is explaining the drama — what is happening to the whole world and what is a designer's role in it. He is a* **sutradhara** *as far as the field of comprehensive design is concerned.*

●●

When he started talking, Dr. Fuller's hands were already busy, cutting out, folding and shaping two colourful cardboard maps of his Dymaxion world (*see next page*). Soon, as if by subtle magic, the flat cutouts had formed a beautiful icosahedron — the most realistic representation of our earth, as he put it.

BUCKMINSTER FULLER: Unlike on any conventional globe you find no discrepancy whatsoever. (*He is referring to his polyhedral globe.*) It is very faithful mathematically to the data of our earth. It has 20 sides — 20 triangles — an icosahedron. All I want you to look at is the data as you find all over the world. There is no distortion. It's a mathematical method of projecting the data of the surface of a sphere on to a plane in such a manner that there is no visible distortion in the relative shape or the relative size in any of the parts. This is the first time you have ever seen the world flattened out without any distortion (to your eye). If you put this together into this polyhedron, as far as your eye could tell, in every way it corresponds to the data you get on the earth.

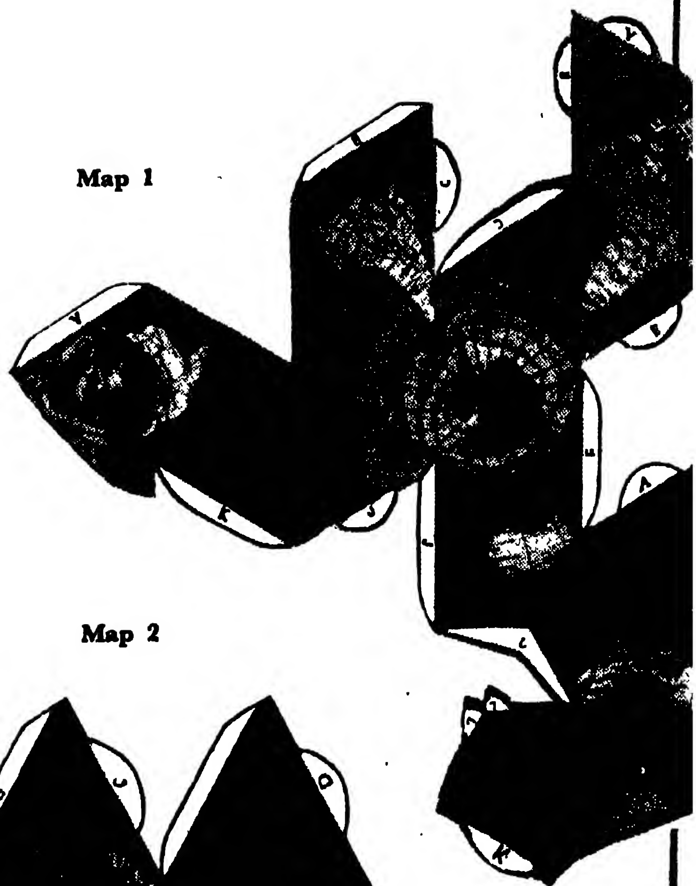


The Dymaxion Map

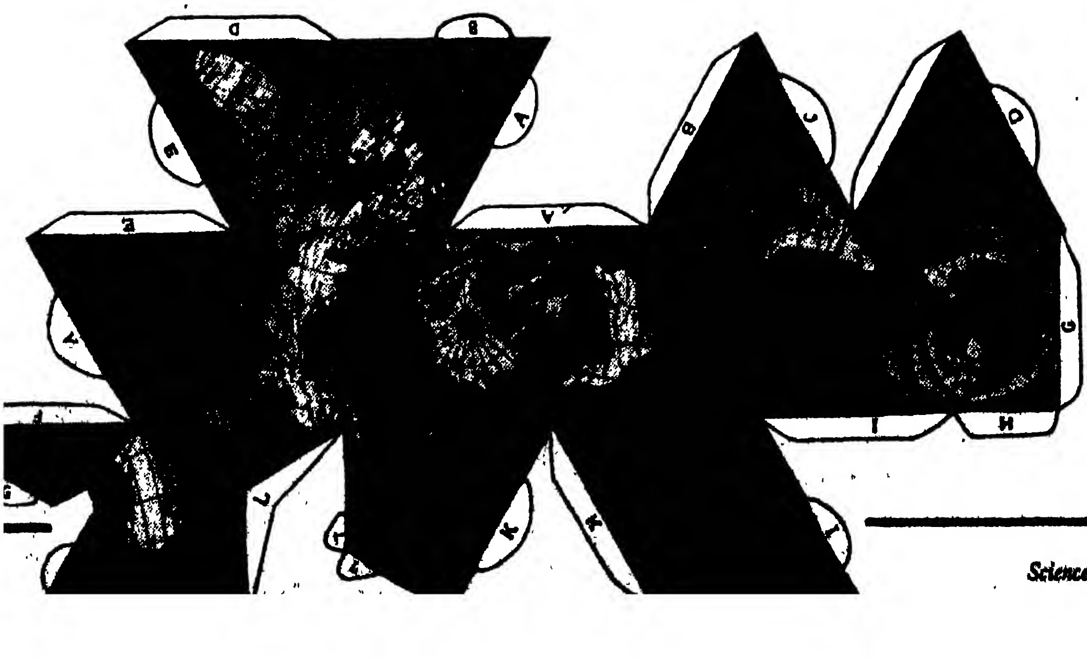
Fuller wanted to have a way of looking at the sphere that is our world without any distortions. He divided the surface of the sphere into squares and triangles in a very special way. Now, when the skin of the globe (that is, map of the world) was removed and stretched flat, the earth became divided very neatly into continents that were linked together, with the oceans all around on the outside. The new map showed the earth was made up of two distinctive parts, a land grouping and a water grouping.

The new map shows all the geographical data of the earth without any breaks in the contours of the continents. Moreover, unlike maps based on the most common method of projecting the spherical world on a flat surface, the Dymaxion Map has no distortions. In the Mercator method of projection, the skin of the globe is unrolled like a cylinder, so that all the lines of longitude become parallel North and South lines, although really they all stretched between the North and South Poles. As a result, the Arctic and Antarctic areas are distorted from their natural size. Thus the Mercator projection map is fine for short-distance navigation, but quite disastrous for global flying or concise planning for intercontinental rockets. *Life* published the Dymaxion Map in March 1943.

Map 1



Map 2



You know there are no true spheres, only polyhedrons. It has many facets. This is typical of me. I find I have to deal experimentally with all information. Physics has found no continuums, no surfaces, no straight lines; physics has found only waves and discrete energy packages that are not continuous. So you say, by a sphere we mean an aggregate of events, approximately equidistant and approximately in all directions from the approximate events — that's the closest you can get — only approximately.

Here the map makes a polyhedron. So what was called a sphere in the past turned out to be a polyhedron. Polyhedrons are really true spheres. Our definition of it is satisfactory to science. You'll find it typical of many of the Greek approaches which were superficial: they took the seemingly obvious. They thought the straight line was obvious; but it is not, because you can't make it. You can't demonstrate it experimentally; you don't use it. There are no continuum surfaces. There are no solids. It took a long time to discover it.

I am now going to give you something quite realistic and this is a polyhedron — 20 facets and that's enough to give it symmetry. Here is then a totally, absolutely satisfactory earth. There are no discrepancies whatsoever. Now here I have it out flat in two different arrangements. One is a triangular group — we see the continents far apart. (*He is refering to MAP I.*)

P. M. *I'd like to interrupt for a minute. Can you tell us when you started thinking, looking at things this way?*

B. F. I think it starts with every child when it is born. Most children start making spontaneous demonstrations of original thinking and the parents say: " Darling, don't say that word; it will get you into trouble. Don't say that man smells because he is your father's boss. Your father will lose his job. " So the children get discouraged in their spontaneous sorties.

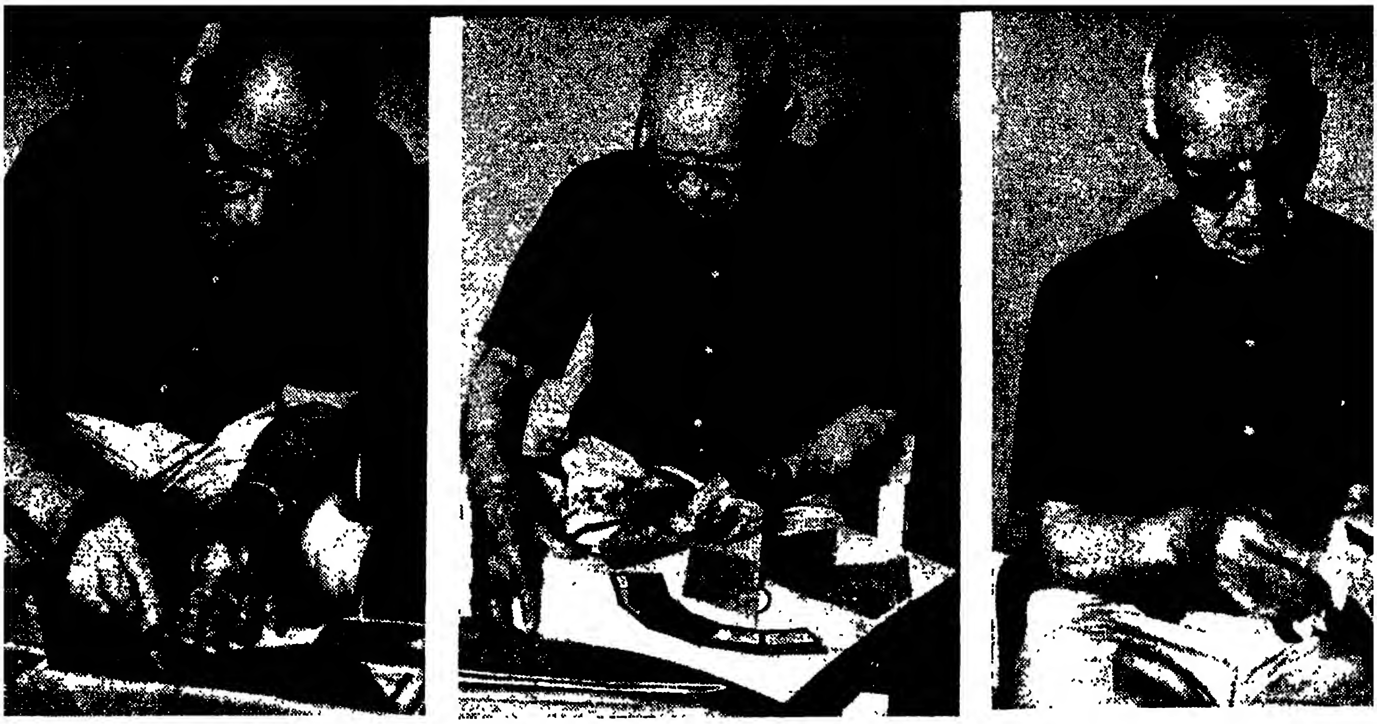
I think I was just able to live through it. Then I said I shall deliberately try to see if I could recall what I felt as a child, to see if I could get back to the fundamentals and describe things exactly as I had first known them — experimentally, as experience — I call them experientially. Experiment is a deliberate experience. Many experiences are equally valid but they are not deliberate. They are happenings and not experiments.

As you begin to understand, you learn you have to discipline yourself. For instance, the words 'up' and 'down' which everybody uses were invented by man to accommodate the idea of a flat earth going into infinity — the earth being a sandwich, an infinite sandwich between heaven and hell. There are mountains and valleys but the average comes to a plane going into infinity. Now all the perpendiculars to the same plane have to be parallel to one another. So the perpendiculars to the earth, if the earth were flat, would only go in two directions — up and down. The moment you know you are on a sphere, none of the perpendiculars are parallel to one another. So the direction 'up' to one person is not the direction 'up' to another — there is no meaning in using the word 'up' — we are going to have a counter-meaning. The proper words are — as the aviators come in for landing and they go out — 'in' and 'out'. You come in to the Moon, go in to the Earth or the Mars. The 'in' is always discrete — in to you. 'Out' is common — it is any direction. It is very interesting, because we are not yet going to obsolesce 'up' and 'down'.

So I am giving you a glimpse of what I began to experience when I became careful about what we are experiencing and being sure we are talking about what we are really experiencing and I began to find out how to discipline myself. So I began to reflect in the terms of the most accurate information. Now everybody is used to the idea of there being something called a straight line. But you can't demonstrate it. So I started deliberately with non-straight lines and it turned out to be much better.

I would like to show you this map. I wanted a way to be able to see my earth to be very familiar with it, not to carry on in the same way society is still carrying on, going about this wide world or the four corners of the earth, and yet not knowing anything about it. While pepole know the earth is a sphere, they are not reflexing that way. When I find a large number of scientific audiences, all scientists, I'm going to say everyone of you scientists have seen the Sun going down and the Sun rising. You've known for 500 years it is not doing so but the point is your senses see it that way. You have not disciplined your senses so they respond to what you really know. So you have two kinds of lives — a theoretical life and an actual life. The trouble is when the critical moment occurs, you still reflex in the way you see it. I find that society is possibly 1,000 years behind its own knowledge the way it's reflexing. This will explain most of our predicaments today.

So I began to say, as you know, if you don't want to have scraps of paper on the sidewalk, the first thing you must do is not to throw your own pieces there. The universe will not get anywhere if each of us did not do it for himself. And if somebody else says he doesn't know how it is going to work because if you're the only one doing it then it would still look very messy, I'll say that's no way to clean the sidewalk.



You must do your own housekeeping first, that is by taking initiative outside yourself objectively, of throwing paper and not throwing paper. Inside yourself you must not allow yourself to go on accepting concepts which are very popular but you know are wrong.

By then not accepting, I suddenly found everything rather simple — truth suddenly became evident. It started to make linkages between the sciences and the humanities that had not been made because of all the discrepancies between the sciences and humanities. Humanity is all the time going along with all its customs that seem to be superficially correct but are actually incorrect — we find society really operating on an almost totally ignorant basis. And yet we get on alright because the design of the universe is itself so competent — things have a mathematical discreteness, and there is gravity to hold things together. It is the integrity of the universe by virtue of which the tree grows. Following these beautiful principles of the design of the universe makes it possible for man to grow ignorantly also. So he is ignorant. However, it is a term you and I use because there is also such a thing called non-ignorance, that is man does have a capability that is not manifested by any other creature or living organism: it is the ability to discover principles, to understand the mathematics of gravity. Not just as the leaf feels gravity pull it to the earth, but it doesn't understand gravity, but man can understand at least the mathematics of it. No man knows what gravity is and what it does and the rate at which it does it. We can calculate the coherence of the atoms, the mass attraction. Microcosmically, all the phenomena are explicable by Newton's law of mass attraction. If you ask me what Newton's principle of mass attraction is, I have to say I don't know, because there is nothing in one of the properties, one of the bodies that is being attracted that says what it attracts or is going to be attracted by. We do have magnets which we know will attract it, but non-magnetic masses will also attract. The mass attraction is apparently completely independent of magnetism.

Now this is to say that when we come to the beginnings of science, we come to absolute mystery. Society, being as ignorant as it is, tends to think that all you have to do is go to school long enough until you learn what it is all about and it really is going on in blissful ignorance. Therefore, it is very easy to come to atheism, for instance, which assumes no mystery. But if you really know the operational procedures of Newton for arriving at his information, or Kepler before him or Galeleo before him and Tychobrach before them, then you discover operationally this a priori mystery, within which a priori mystery, this extraordinary elegant mathematical reliability is manifest. That was a very different way of saying things.

Anyway, I spoke to you about not throwing a piece of paper outernally and not allowing yourself to have refuse internally of yesterday's bad thinking, or lack of thinking — we wouldn't call it bad thinking — it is lack of thinking — ignorance is non-thinking. Man is the only *thinking* creature. He finds principles which are absolutely weightless, absolutely abstract which no other living organism does. Now this is how I became deeply interested in house-

cleaning all the way through, particularly, looking at my own planet which is really very small in relation to the universe. I could really feel it, feel it revolving in the presence of the Sun, as also in orbits around the Sun. I travel a very great deal around our planet — I make circumnavigation more than twice a year — and many people say to me " I don't see how you can stand all that travel ". And I say to them you obviously don't know what you are doing. Because on our own planet we are making 60,000 miles an hour around the Sun right now. You are making millions of miles annually around the Sun. And there are even extra revolutions. Your motion is so great that my little motion around the planet is negligible on the size of our mutual travel. I found men reporting about going to the Moon from our planet. They paid no attention to the speed of the Earth and the Moon flying in formation around the Sun. They only gave the acceleration of the vehicle. They said it was making 15,000 miles an hour. To which you will have to add 60,000 around the Sun. So it was making 75,000 miles an hour and not just 15,000. This was completely left out showing here is man getting to the Moon and still being very ignorant about what he is doing. And we have Armstrong getting to the Moon and speaking about being ' up here on the Moon '. There is no direction up and down in the universe.

P. M. *Many years ago you gave me a book called* Nine Chains to the Moon. *Now is this concept related?*

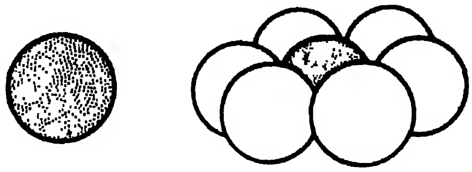
B. F. *Nine Chains to the Moon* was because I found man was so very tiny on earth. I'll give you quickly those figures. When we look at the Sun, its corona (when you get the proper filters and great lenses, you *can* look at the Sun), you can see some of the flames on the Sun. Very frequently, the altitude of a flame on the Sun from the Sun's surface is as much as 100 times the diameter of our Earth. That will give you an idea of how fantastically tiny our little Earth is. Now our Earth is 8,000 miles in diameter — yet the distance to the Sun is 92 million miles which is absolutely negligible also. The next nearest star is approximately a billion times farther away than the Sun. So when we begin to talk about these two nearest stars to us, they get into sizes to which 8,000 miles is absolutely negligible.

Now taking our 8,000-mile-diameter Earth, if we have a globe that is only 12 inches in diameter, 1/8,000th of that will be a very small amount. The highest mountain — your beautiful Himalayas — will go five miles outerly and the deepest ocean 5 miles innerly—total of 10 miles differential. Ten miles in relation to 8,000 miles is 1/800. So if I take a 12-inch globe, and take 1/800th of it, it is invisible to our eyes; it is just a polished steel ball that is still referred to as our earth. In relation to that, if you think of a differential between our highest mountain and the deepest ocean, then we find a mile is 5,000 feet, and an average person is about five feet — between childhood and grown-up — and it takes a thousand people standing on each other's shoulders or each other's heads to make a mile. In other words, the differential between the highest mountain and the deepest ocean is 10,000 people standing on top of each other. So 10,000 of us standing on a 12-inch globe — well, you couldn't find it, because we found you couldn't find the ten mile difference. Now this gives an idea how tiny we are.

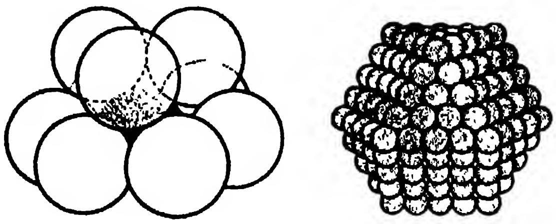
(Continued on page 32)

'Nature's own geometry'

IT began with a strange game Bucky used to play in the evenings. He would take lots of small spheres, all the same size, and then stack them together as closely as possible about a central sphere. First, he would put down one sphere, then six more around it. He could add



only three more on each side to touch the centre sphere. The outside layer was thus always composed of twelve spheres. And here was something familiar -- this pattern of crowding together was one that always occurred in the universe.



Bucky went on further and discovered a second layer of spheres, put down to cover the first completely, always had exactly 42 spheres. The third layer would take 92. Bucky looked for a name and called the pattern "the closest-packing of spheres." (Many years before, Barlow had suggested this principle as one way of describing the atomic structure of common salt and other crystalline forms of matter. And about the same time he was playing his game, Sir William Bragg had discovered the same principle in his work on X-ray crystallography.)

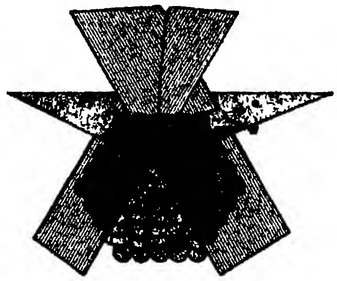
Bucky had stumbled on a formula:

$10 \times (\text{the number of layers})^2 + 2 =$ the total number of spheres.

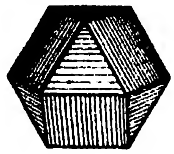
Thus, for the first layer,
$10 \times (1)^2 + 2 = 12$

For the second, $10 \times (2)^2 + 2 = 42$ and so on.

He had found a beautiful natural number magic. Now he tried to picture geometrical plane surfaces that would be just touching, or tangent to the spherical outer layers.



He was surprised to find the planes did not form a regular solid but a 14-sided polyhedron of eight triangles and six squares.

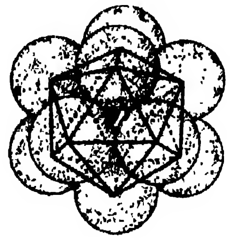


It was a puzzle, but then one day he found the clue. The sides of each of the 14 faces were all the same length, whether they bounded triangle or square. The lines met in 12 points, or 'vertices', of the polyhedron. And the lines from each of the vertices to the inner centre of the figure were all equal to the lines that formed the external faces. And here he came across vectors.

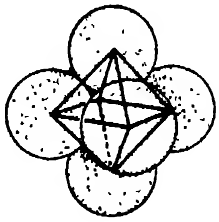
He could picture his geometrical figure in two ways. First, it was being 'held in' by all the equal *outside* lines that joined the vertices. Then, it was also being 'pushed out' by all the equal

lines that radiated from the inner centre to the vertices. These pulling-in and pushing-out forces were all equal and that kept the equilibrium. That meant his closest-packing polyhedron really represented a *vector equilibrium* in nature.

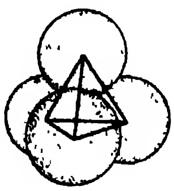
Now, what would happen if you took out the centre sphere? Bucky tried it and the vector equilibrium changed. The sphere readjusted around a central vacancy and more polyhedral planes could be formed. Six more sides were added and each side was now an equilateral triangle. The vector equilibrium had become an *icosahedron* — the 20-sided figure that was one of the five known regular polyhedrons.



Suppose you took some more spheres from the centre? It would shrink ! It would become an *octahedron* — two pyramids with their bases



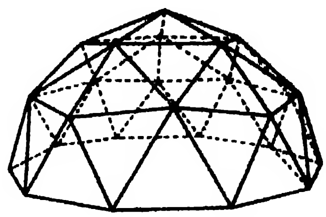
joined. If you let it collapse further, it would become the simplest of the regular solid polyhedrons—the 4-sided *tetrahedron*. You couldn't



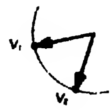
go any further: here was the most fundamental geometric form in nature.

Now he had to work out the system. He had found that the triangle is the figure that supports itself most rigidly with the least amount of effort, and all push and pull, all stresses moved along triangle lines. When he built models, it proved to be true. Yes, the tetrahedron, the octahedron and the icosahedron were the only three absolutely stable figures.

Now, suppose, you push the sides of the three basic polyhedrons outward. Bucky went on making more and more triangles out of each side, and found that each of them finally approached the perfect solid shape called a sphere. The vertices of the tetrahedron became points on the surface of the sphere.



Now, Bucky started working on this change from polyhedron to sphere in the form of forces. He saw that the great circle bands between vertices represented the largest amount of pushing out by the internal vectors of the system.



But if you draw straight line *chords* between these vertices, you get the largest amount of pushing in by the external vectors on the system.

If the external vectors were greater, your sphere got pushed back into the shape of a tetrahedron — least amount of space or volume and the greatest amount of surface.

If the internal vectors were greater, your tetrahedron was blown out into the spherical shape — the greatest amount of space or volume and the least amount of surface. Bucky concluded that systems that were built up out of combinations of symmetrical triangles provided the best conditions for distributing energy. You could make these triangles out of great circle chords joining vertices on the surface of a sphere. By subdividing such triangles into smaller and smaller ones, you could reach the point where your system provided the greatest possible resistance to inside and outside forces. Bucky named the structure built up by this process a 'geodesic' structure.

[*The explanation and the diagrams of Dr. Fuller's new geometry have been adapted from Sidney Rosen's* Wizard of the Dome.]

(*Continued from page 29*)

Yet I find the human mind is able to discover principles in spectrography. Electromagnetic frequencies are absolutely invisible to the human eye but photographic emulsion can catch it. We are taking the light from every one of the stars visible in our heavens and we take an inventory on board our planet; human mind has an inventory of all the chemicals on the universe, at least all the visible universe. We also know the relative abundance of the hydrogens. Now if our mind is able to do that kind of exploring in tens of stars that are million light years away, it is a very extraordinary manifesto of how great man's mind is but how tiny he is physically. But he being born ignorant, is born helpless, naked, absolutely ignorant. He may have beautiful equipment to apprehend information, yet he has no experience. Being born absolutely helpless means he needs being taken care of or he will perish. At last we begin to see human beings as the most complex organisms operative in the universe short of the universe itself. Though tiny that we are, we have principles operative within us almost equivalent to the relative abundance of principles in the universe. So, we see our miniature universe is locally present, and that there should be such a complex local organism means there must be some significance, there must be some function. You find everything in the universe is in the functioning. You see this very complex organism as a information gatherer and processor — it must have a very important function. And I am really convinced, yes, we are here because in all that the universe defined physically is it is infinite and infinitely regenerative. In order to be infinitely regenerative, continually transforming, there must at times be very complex problems.

The scientists always have their answers, they are always following great laws — but there must be some times in the universe, where nature has her complex problems and she needs local capabilities to understand great principles. We all experience this — this is absolutely universal to man — his problems, all day long his problems. We are here as problem-solvers. To sort, to sort, to sort. I have tried to understand, to apprehend, to comprehend, to understand the interrelationships we all have. This tells me then our function in the universe is to be a local problem-solver in terms of some of the fundamental principles of the universe. Not in terms of reflexibility but in terms of the mind.

So understanding that is what man seemed to be here for, I began to see what we can do, how we can help him function in this manner. But we see him born helpless and he has to be looked after, just as a tree has to be looked after. But gradually we discover that as he is hungry, he is sure to take on chemistries to regenerate. So we give him hunger so that he will be able to take on the right chemistries. We give him thirst. Nature takes no chances on our keeping our heart going — she keeps it pumping all the time. She takes no chances on our making new flesh — we are 99 per cent automated. Now in that pattern of man being born, with all this automation, and a few conscious senses which he gratifies, particularly that one of knowledge — gradually he learns the behaviour of sciences. Man learned through the food that he needed that this berry will kill him and this will not and he gradually began to discover principles; he gradually then began to put it into operations of the mind which is his whole function.

We now know of man's presence on the earth at least for 20 million years and he is just breaking through the point where we begin to know we really are on a sphere, that we really have common language, that we all have vocabulary. Yesterday you didn't have any vocabulary, you were very hungry and diseased and dying very early and had to live like a big man with a sword. Because in the physical world, next to the matter of being hungry, the biggest man is somebody who finds it very easy to knock down the little man. You want to take advantage. You find man being physically operative right up to now.

This is typical for India, for instance. India has been vanquished time and again — with the Moghuls coming over the mountains or somebody from Europe coming in — physically vanquished, and because man then tended to respect the physical, the sword donned the fist. The sword for India was secondary. All the time India has been thinking — for thousands and thousands of years — of intellectual integrity, and if there is a breakthrough into the new, then suddenly India is going to come into a very great prominence. India and China had this long thinking. I think this is going to be heralded as a great moment. Mahatma Gandhi, by using the mind and thinking about it, being very well-informed, realised passive resistance can overcome the sword. He was using his mind to defeat the physical, and then really break the last of the great world empires.

Now I see we have to go further than Gandhi, than just being passively capable. I must be objectively capable also. With the mind. When a man was specialised, he came to a strong man who said "you may be a thinker, but you've the mountains to think about and don't bother me with that thinking staff". Thinkers are very dangerous people. The king wanted one very good grand vizir and he showed him how to conquer some more and how to keep it. What you could learn is to divide and conquer. The big man is like the big horse. There is a herd of wild horses and every once in a while a young stallion is born that is bigger than

all the other stallions. And there is a great big old stallion who is head of the herd. The old one challenges and has a big battle with this young one. And whoever wins is the one that will inseminate the herd. The other males can go away. They are not wanted. This is what Darwin meant about survival of the fittest strains, of the toughest. I'm sure the early man among the mammals was being born helpless and ignorant and just physical and yet was a big man. He didn't ask to be big and yet he suddenly found himself born bigger than the other guys. And there is a big king over there. And there is a young man who comes out and they have a battle and so this young man is the new king. Lots of other men of the tribe would like to be the king, because they see the king eats more regularly than the others.

Man also learns he can lick this one and lick that one, but can't lick two of them coming at once. The most instinctive strategy of physically mastering is to divide and conquer. Now anticipatory divide and conquer is better, that is " don't let those two strong men get together and plan things to take you ". So you make him a lord and him a lord and get your spies to watch what is going on. The strong man needed the spies, he needed intellectuals, he needed men who understood metallurgy so that they could make him a better sword. But he didn't want those intellectuals to get going, he was afraid of the sword; so he made them all specialists. " You mind your business, you just make swords ". " You just report to me what my enemy is saying over there — you learn his language ". " Would you just mind your business? You are going to eat regularly if you mind your business. " You find this in the whole educational system in developing specialisation — simply, this is the strategy of the physical mastering the metaphysical.

As little man began to learn, the information got proliferating out mainly through radio and television, that's the way it really got loose — through radio and television. Into every home came a voice. Up to then papa came home and gave the children the news or the mother got it by gossip. But suddenly in the house there was a little radio and the little child was saying: " Mama, Papa, man has got to the North Pole ". The news came over the radio and from the man on the radio (who was chosen for his job by virtue of his diction and his vocabulary and his versatility in using the language). And the child paid attention to the voice with the best diction and the one with the best information. It became the authority. So the radio in the home and the television in the home became a third parent. And that's how a parent told the children all about the world, about all his troubles. So instead of thinking locally — parents were thinking very locally — the television and the radio made them think about the whole world.

The whole world becomes literate by virtue of that little voice coming over the radio or television. Wherever I go, there is literacy. When I was young, just in my own time, all the men I worked with before were illiterates — very skilled but illiterates and very fearful lest somebody learn their skill, because that's the way they could make sure their family was going to eat. So I find man full of fear today, in all these states and in all these organisations—whether they are trade unions and whether they are great corporations or whether they are great governments — these are all fear organisations — on the basis of there is not enough to go around and there has to be a showdown between you and me. That's right. We get from last year's annual budget for arms of the United States, NATO, Russia, China — 200 billion — that's typical of each year of the last decade — 200 billion with all our creative capabilities. That's the highest creativity and that's because all the ideologies assume that there's nearly not enough to go around. But I have a slightly better way of solving the problem — a little more kindly, a little more just — i e despite assuming failure, how to get on under failure.

What I was beginning to learn as I began to look at things comprehensively was that we were beginning through knowledge and principles to do more with less. I found that the East India Company which was running the world in 1800 had as its chief economist Thomas Malthus. Thomas Malthus was the first economist in the history of man to perceive the actual data about the empire; all the empires up to now have been flat empires — whether it was Ghengis Khan or Alexander the Great — it was a plane going into infinity and there was something called civilisation and the empire was within it, but beyond that, everything went to drag on into infinity. Thomas Malthus was the first economist after man learned that he was living on a globe, on a sphere. That made all the difference in the world — mathematically. Because if he goes into infinity, there are an infinite number of variables, and you find that there are an infinite number of gods, and you have to get the right god if you are going to eat. So everybody had hopes for finding the right god — so you have got infinite number of hopes. But the minute you close this thing, you don't have an infinite number of hopes. *That's all there is, there isn't any more.* And it has been so since 1800, since 1810. Thomas Malthus's book had this great economics where he found that man apparently was multiplying himself geometrically, but was producing goods to support himself only in an arithmetical rate; therefore man is designed to be a failure. And 30 years later, you have Darwin as one of the biologists being taken around this spherical world —

a closed system — and being told " these are all the species there are, there aren't any more ". Darwin couldn't have developed his theory of evolution in the Roman Empire because he would have had to include dragons. You cannot develop any theory till you have a closed system. So Darwin suddenly had a closed world, and he had a theory of evolution and he explained it as survival only of the fittest. Here you have the discipline, the essence of Karl Marx. Malthus and Darwin were right — when you don't have enough to go around, it is survival of the fittest. Marx said the worker is the fittest because he knows how to handle the seed and the land and he knows how to handle the tools. He is inevitable in nature and these other people are parasites. And it was the great monarchs of the sea who said we are the best-informed, the best-equipped, we are the toughest physically, we are the fittest. All the political theories were somewhere between these two extremes, since the time all of them assumed there isn't enough to go around.

P. M. *You think of this world as one globe. But you also see many powers and political tensions; and I believe you are doing something about it — about the world citizen. Could you tell us something about it?*

B. F. That brings me back to what I was saying. I saw Gandhi then using the mind — but passively — and that won't help anybody either. I am interested in how it can be a positive, instead of just a negative, defensive thing. I would like to be offensive, capably offensive, but then metaphysically, not physically. And my strategy came about by understanding this: I am a sailor and, as with ships, you have to have floatability. On the land where 99 per cent of man was in his ignorance, he put bigger and heavier walls — all over India, all over the world. The bigger and the heavier and the thicker the walls, the more secure he felt. On the sea you couldn't do this; in fact, if you had a little boat, you could outmanoeuvre a big boat. It was a question then who could do the most with the least. Three quarters of the earth is covered with water. And whoever controlled the water, controlled all the people.

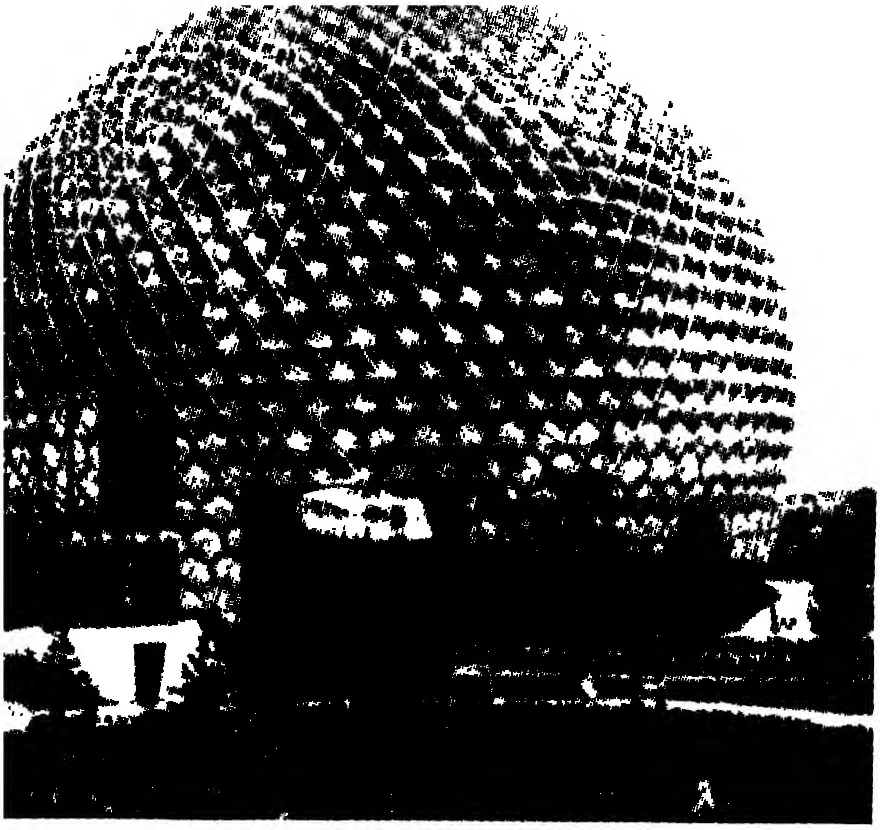
Let's take a look at this map (Map 1); this is the way the world was yesterday. Its continents were very far apart. The only thing that joined them was the water. And whoever ruled the water ruled the world. And whoever was going to run the world would have to master floatability. But all these laws of man on the land could not be enforced out on the water. So three quarters of this earth was outside the law and the people on the sea were outlaws. And the only law was the law of nature, the storm, or whatever that is the winds do, or whatever the waves do and they were very ferocious. You had thus to understand their laws in order to do with them, with displacement — whatever may be the size of that ship, but while on the water, the weight and the volume of that water displaced was all you could float in it, your cargo, your arms, anything. Now this brought about engineering. This gave rise to navigation because you went off to where there was no island to be seen, no land. All the great sciences and engineering started from the sea and started doing " more-over-the-less ". So you say: " You are my enemy, and I see what ship you are building. I'll build one too, same size; you won't overdo me. It's a matter of who has the strongest fibres in the mast, who has the strongest fibres in the ropes, who has the strongest fibres in the sails. So when the wind is really blowing, you have to take off sails because your ropes were breaking, and I don't because I am stronger. I do more with less, I do more with the same amount or with less." This became the law of the sea. And whoever did the most with the least stayed on top of the other.

I was in the navy and we had refrigeration at sea 25 years before refrigeration came up on the land. We had such great engines on the ships at sea that they didn't have on the land. All the great electric generators were first on the sea. You had to have air-conditioning equipment to force draft in to get oxygen to them. All the great technical equipment we had was first on the sea. The steel blast furnaces were making steel for the ships at sea 50 years before they used a piece of steel on a building on the land. I was on the regular navy and I saw refrigeration and I said Thomas Malthus didn't know there was going to be refrigeration; he assumed that food was going to rot over here, it would never get to the mouths over there. So I said what else did Malthus leave out? I began to study how through the use of the mind and principles we began to master problems — we did more and more with less and less. Between the automobile engine and the aeroplane engine, in 1913, one year before World War I, both weighed 7 lbs per h. p.—both reciprocating engines. In 1927, 14 years later, the automobile engine was still 7 lbs per h. p., but the aeroplane engine going down to 1 lb per h. p. You were doing 7 times as much for the same amount of material. We were going much farther, much safer through the air. So I found there was a great trend to be able to do more with less. Take a piece of aluminium. Up to 1932, the best aluminium we had pulled apart was 16,000 lbs/inch tensile. After that its strength began to go up. Just before World War II, you have a piece of aluminium twice as strong— the same material giving twice the strength — it

went from 16,000 to 32,000. Then during World War II, we double out again to 64,000. We now have taken the same weight of material and given you exponential to the geometrical third power augmntation. This is typical of alloys. Now one communication satellite, weighing a quarter of a ton, is outperforming the transoceanic communication capabilities of 175,000 tons of copper cables — 175,000 against one quarter. Multiply, 175,000 by 4, we get 700,000 for one. This little thing is doing 700,000 times as much — at a fantastic speed — communicating around the world.

This is then how we do more with less. So I began to see in 1917, and more clearly in 1927, that it was possible to do so much with so little. We could take care of everybody and, therefore, the fundamental reason for war, which is somebody is going to die — they are going to be in poverty and starve to death and have a choice between a slow death in the slums and a faster death in the wars — but death premature for every body — I saw that that need not be since we could do so much with so little. We could continually increase the health, we could take care of more and more people. I began to really study what is necessary — a house for somebody, for instance. It should be strong enough to withstand the hurricane, the typhoon, the snow loads, whatever it might be. I found that I could enclose space for only 3 per cent of the weight of the material by having the right geometries, the right engineering, the right understanding principles. I could now take care of 30 times as many people; I could give 30 buildings for one now, that would have no columns inside but yet was capable of taking all the stress like hurricanes, earthquakes, the whole works.

Now it became clear to me that it is highly feasible to take care of everybody, that we need not have an old law of philosophy of assuming negatively that man is supposed to be a failure. I see man born as a little child inspired by every body because he is designed to be a success; it is only in our ignorance we say: " No, you are supposed to be a failure ". Every little child is taught by the grown-ups against the background of fear and this negative idea that life is a failure. Grown-ups, when they see a little child, say, "Don't be so hopeful, you are supposed to be a failure ". So I began to be different. I said it isn't a matter of being a philosopher, in the contemplation of the mountains any more; it's a matter of using our mind, to rearrange the physical environment, to become master of the physical. To do more with less, you must reduce your philosophy to some kind of practice, to make tools, to employ the principles of labour. You must learn the principles of your mass attractions. There are only very few principles operating in the universe. Never mind all those special cases, learn your general principles and keep solving problems. How do we make, how is it possible to make all of humanity a success? How do we free him, eliminate restraints on man, make it possible for him to go and enjoy the whole world?



Fuller's dome that was the US pavilion at Expo '67

. . . There is no direction up and down in the universe. And here all the politicians are saying never mind the space, let's get down to Earth — which is as if saying there is a flat earth going into infinity in the sky — something abnormal — paying no attention to the fact that we are a space ship, we are a space programme . . .

Humanity will find manifest number of things that need to be done. But man had so little hope about it yesterday — now I see it was without communicating capability. It's another kind of experience you have when you record what I say and we can publish that and more and more people begin to understand that yes, it is possible. We can make a success of our man on our planet, freeing him at last, graduating to where he is supposed to be, to be in a position to be able to attend to some of the very extraordinary problems of the universe. Probably we are impounding energy on our planet here; someday there will be so much energy impounded, it could become the Sun. For the moment it is a place where energy is being impounded and the stars are giving off energy. It is like our weather — atmospheres have high pressures and low pressures, the low pressures exhausting the highs, then they become the high and there is a new low over there. So there is a process in the universe of collecting and dispersing. We are placed where things are being collected at the moment, being sorted out, and compacted, someday to become a star. By that time man will have gone many planets away, so he is not going to burn up; we must by that time be able to be on some other galaxy, some other planet.

In other words, we are beginning to begin a new mission, operating round the universe, helping sort out these problems — how to really get to very complex matters. Imagine the secret process, the biological process of making coal—the fossil fuels—the numberless things that have to happen just in getting the stardust to the top soil, the millions of years to get the things sorted out before the biological life begins to impound the Sun radiation and then to get it down under enough pressure, deep enough to bury the Sun to make the fossil fuel. That is what we are—we are an energy-depositing account of the universe — a savings account. And man begins to see those beautiful big things. So he begins to understand people are very ignorant when they talk about pollution. All the chemistries of the universe are of utter importance. Nature does not have any pollution. Man, of course, does not know the substances, so he calls it pollution. These are all very valuable substances.

We are undertaking some very big things now. Like you look at the map with me (Map 1) — there is the total surface of the earth which I showed in a polyhedron or a globe. I could take those triangular pieces and put them in any kind of arrangement I want (say, Map 2). Now you are satisfied these are the same maps. This is the way I found the world when I was born in 1895. I was 7 years old when the first automobile came into Boston — the town I lived in. I was 9 years old when man learnt to fly. I was 12 years old when the first radio SOS came from a ship. I was 14 when man got to the North Pole, 16 when he got to the South Pole. All these events are very very recent; it is hard to

imagine in your age how fantastically recent they are. My father was a merchant of leather and tea, importing by sailing ships — from India and Argentina to Massachusetts and New York and Boston. My father had to go to South America. Took him two months to go to South America and two months to come back. He had to go to England first, because they monopolised the routes of the old drake ships — then he went to South America and then back to England and then over here. Two months. Then he had to go to India for his leather and tea business. Took him six months to go to India.

Of course the people who controlled the seas would have to let him get through in to there. And it was only by making friends with people who were masters was he really able to be in such a trade.

Now, this is then the way the world was. And Kipling said: "*The East is East and the West is West and never the twain shall meet.*" This is the east and that is the west. This is the far west over here. And you see this enormous distance — there was Europe and Africa all at one. That is the one-ocean world and only the sea has connected things Whoever controlled that controlled the world. What you are looking at is the picture of the British Empire.

And suddenly this is changed by doing more with less — by getting into the sky — man going ahead from being a barnacle on the rock, having roots, staying near. Why did they have to have the roots? Because man has two feet. The tree has real roots, the grass has real roots. You and I, to be able to be regenerative, to regenerate life, we have to have Sun energy —radiation. And you and I cannot get enough through our skins to keep us hot, keep us from being hungry. Vegetation does it for us on the dry land and the algae in the sea. It does it by exposing so much surface to the Sun that it gets dehydrated and it has to have roots to get water-cooling, continually water-softened. So we have osmosis working all along to keep it from being dehydrated. Vegetations thus have to have roots. And where there was vegetation, was where man could survive on that map. (He learnt about fishing, but not till he learnt how to float — he had to be able to stay on water.)

The places where life could be supported were really very few little spots. I find it was less than one per cent of the total surface of the earth which was immediately able to support human life. These islands that are out here are really the best places of all, with their fruits and lagoons — big seas are broken with local fishing inside — and plenty of fruits and no big animals to eat up the little man. So I think he really started in those islands and then he gradually came over to the mainland. That seems to be the opening of the way how he got here. When you think of man being born naked and helpless, you can't think of man being born where it is cold and he will freeze to death; he can't be born where there is too much Sun where he will be dehydrated. He must be near the water, he must be where the big animals won't destroy him. So the only place where you really have all the right foods and no big animals is in those little islands. Then he gradually learnt about floatability and he gradually began to come up on the land. So he had a raft which would take him to the land where it was safe in the day time, but at night he was back on those boats or rafts. Then he began to domesticate those animals, domesticate the horses and domesticate the lambs or the sheep and the goats and the elephants: here on the land he could now hibernate because he could put on the goat skin and even eat the meat. And he could make himself huts and he began to get into the caves and gradually his skin began to bleach out. And because he was born naked under the hot Sun, he started with a dark skin. And the light skin was simply people got it being insulated for million years — there was inbreeding with the chieftain and the grand daughter — being isolated, not following the ship and getting to be what may be called different kinds of nations. Nations are long-isolated, inbred groups of people.

Now, I am giving you a very big picture of humanity, but I want you to understand that these are the tiny little spots where life could be supported; it had to be impounded by the vegetation, and the vegetation had roots, and man having to survive had to stay near those roots, because he didn't have any refrigeration and he had to be near the food. So we begin with him having roots, but gradually learning principles and what has happened today is that we don't need to be near the roots any more. The tools can produce those foods and produce them very much better now — very few amounts of energy and very few people using their heads can really make this thing work. So man is leaving the farm and he tends to go to the city — he is tending to begin using the legs and he is becoming the world man — not being local any more — a really universal man, to begin to leave the planet and go into the universe in various ways. So I saw then man going into the air and the air gives so much more for so much less. In 1961, three jet aeroplanes carried more passengers across the Atlantic Ocean than the *Queen Mary*. And that for only one-tenth the transit time, and for only one-half the cost.

Now the way you get energy from here to there is in no way like ultra-high voltage. You could only send at 350 miles an hour; now, say, you can do 1,500 miles. Pipe lines, tankers and all those things are

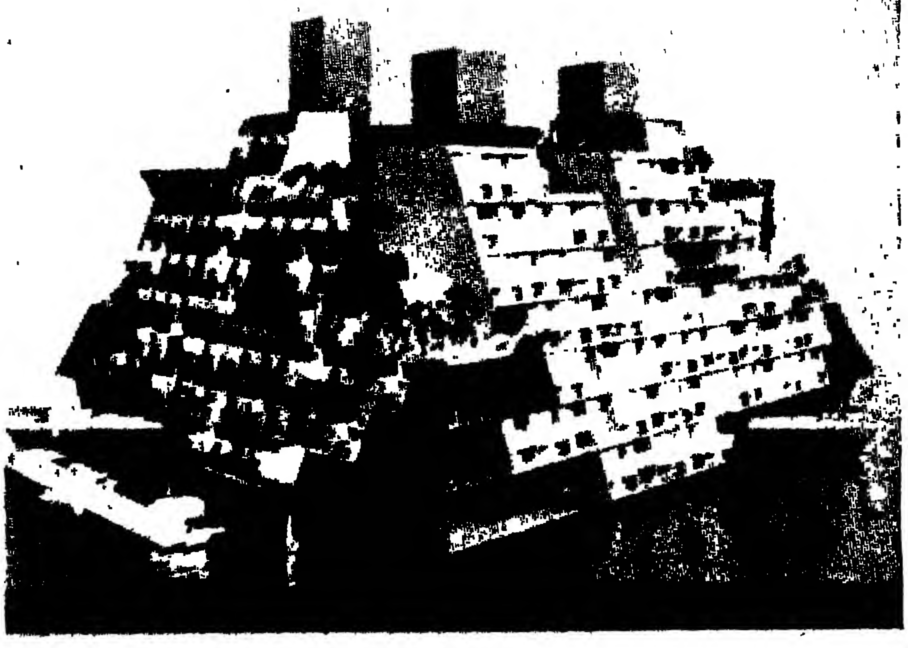
simply obsolete in terms of energy sent by wire. We begin to come to electrical energy network. We began with what I may call an East-West world. Men were then way out here, remote from one another. Suddenly we transferred to this world, where 90 per cent of humanity can reach each other on the shortest air route without going near the Atlantic or the Pacific or the Indian Oceans. We went to the 'sky-ocean' world. Now any one of us can reach each other within 12 hours — physically. We reach each other within split seconds electronically. Here is a new world — a one-island world and a one-ocean world. Now this will be the new traffic pattern. Here we are in India. We call it the 90th meridian. We are coming to the North-South 90th meridian — here it goes right through Calcutta, right through Lhasa, right through Russia and in Canada it suddenly becomes very very important. So here is the new neighbourhood.

We are really going through something severe in the change of man on his planet. It is like a child being inside the womb, where he can be protected and nourished, and he suddenly comes out of the womb — it is a new kind of existence. I see this coming out now. Gandhi saw the beginning of that birth — using the mind instead of the sword, instead of the muscle. The physical is not going to count any more; the mind is the only thing that really counts and will be integrated instead of the divide and conquer that the physical used to do. Now it will be integrated by information — by the way we do things together spontaneously because we know that's the way gravity works. We are well-enough informed; so we don't tend to be in conflict, we will not be doing things the way they were done with an overall assumption of failure.

P. M. *If you believe in this idea of doing things co-operatively, then where will the competition be? Where will the competition concept operate?*

B. F. Competition will be, after all, like mountain climbing, where everybody must get to the top. It's not to leave somebody half-way where he can fall off and die. This is a different kind of a game. There are two kinds of games — you *or* me and you *and* me. They are equally good games. The competition in the you and me is to see who can help the other most effectively — that's the competition. Who can understand most effectively on behalf of this other man. That if you really understand it better, I'm going to honour you better. We won't be doing it on the basis of you have to do it to survive but because it's a joy to understand and it's an inspiration to understand on behalf of the other man. I live in that world realistically. I am 76, but you can see I am as excited about life as when I was 4 years old.

We have to graduate. There is nothing wrong with the umbilical chord, but after the child is born you throw it away. There have to be the moments of man being physically self-started . . .



Model of Fuller's Tetrahedral City

VIKRAM SARABHAI

My Friend & Colleague

M. G. K. MENON

After him, who? Everytime somebody dies, somebody else would ask the question. In most cases, the speculation doesn't linger long. Sometimes it does, because you are at a loss, you can't think of a replacement who would be as good. That is a measure of the man's talent. It had happened after Bhabha died. Then four months later, everybody thought: will Vikram Sarabhai wear Bhabha's mantle well? Today, barely six years after, Sarabhai appears to be irreplaceable.

Six years is a short time for doing anything, achieving any results. When you grow up, he used to say, you don't have to walk step-by-step like a toddler; you can leap, run, you can take short-cuts across the fields. That means you have to start processes, not like a gambler but like a prophet, infallibly accurate as to what the consequences will be. That's what he had tried to do with atomic energy and space research.

But six years is a short time. You find an able man and you put too much on his hands. He is always on the move. Too many planerides. Too many committees. Too many symposiums. Too many subjects. It tells on his efficiency. It tells on his health. Maybe if he had more time and less on his hands...

Indian science is going to miss him. He had a way of getting things done — with a sense of justice that makes you ready for a difficult job. As we wait for the right man to take on his mantle, the pain of loss is also edged with worry.

VIKRAM Ambalal Sarabhai was born on 12 August 1919. He had his early education in Ahmedabad. He then went to Cambridge (England), where he did his Tripos in Natural Sciences in 1939 from St. Johns College. On his return home, he joined the Indian Institute of Science in Bangalore, attracted by the genius of Professor Sir C. V. Raman. Professor Raman had told me that it was his intention, when he moved to Bangalore from Calcutta, to initiate work in the exciting new areas of nuclear physics and cosmic rays in which there had been spectacular developments. But due to several reasons including lack of proper support, this did not turn out to be possible. It is remarkable that Vikram Sarabhai, working with Professor Raman, did research in cosmic rays; this was partly a result of his Cambridge background; as it turned out, he was the only student and colleague of Professor Raman to work in this area. Vikram Sarabhai was in Bangalore during the years when another genius of Indian science was there: Dr. Homi Bhabha, whose interests were in cosmic rays, nuclear physics and high energy theoretical physics. In the impressionable and formative years of his early twenties, Vikram came under the influence of these two outstanding men of science; and one can see effects of this influence on much that Vikram did later in life in science and technology.

With the late Sir C. V. Raman at Ahmedabad, December 1968

From the Indian Institute of Science he returned to Cambridge where he did research on photo-fission at the Cavendish Laboratory; he took his Ph D from there in 1947.

From his early childhood Vikram was deeply interested in science. And for him, science was not to be just a part of a liberal education, to fit him for a career in business, industry or administration. His interest in science was deep and abiding and he meant it to be the central theme of his life and career. He did participate and play a significant and dynamic role in the textile and chemical industries with which he and his family were connected. It was there that he acquired the industrial experience and business acumen, with the fundamental concepts of cost-consciousness and profitability, which he used later in his many endeavours on behalf of the people of India to apply science for effective practical purposes. At the same time, he set up for himself a research facility in Ahmedabad, where he could devote himself to his basic love, namely fundamental research.

THE social impact of innovative man has hit society like an avalanche. Scientific advances and technological innovations along with their social and political implications have suddenly overtaken the pace of the human life cycle and produced a crisis of obsolescence.

Many political implications arise from the military uses of outer space and surveillance by satellites. National security and sovereignty have been eroded while privacy has been encroached upon. When security is threatened not by a hostile neighbour but by the actions of distant powers, what is the relevance of traditional concepts, in international relations such as spheres of influence and power politics, of bases and alliances? Obsolescence of thinking and patterns of behaviour in international affairs pose today a most serious threat to out survival.

[Vikram Sarabhai at the UN Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 14 August 1968.]

Vikram Sarabhai worked in the field of cosmic ray variations, and set up a group which was undoubtedly the best in this field and which achieved recognition in international science. He was for some years secretary of the internationally instituted Sub-Committee on Cosmic Ray Intensity Variations (SCRIV) and was also a member of the Cosmic Ray Commission of the International Union of Pure and Applied Physics. In his efforts to grow an institution of pure research in Ahmedabad, he was joined by Professor K. R. Ramanathan, who developed research groups in areas of ionospheric, radio and atmospheric physics. And this was the Physical Research Laboratory. As the Tata Institute of Fundamental Research was the cradle of the Indian atomic energy programme. Vikram Sarabhai made the Physical Research Laboratory the cradle of the Indian space programme.

With Bhabha, a fellow traveller

In many respects, the lives of Vikram Sarabhai and Homi Bhabha were remarkably similar. Both Homi Bhabha and Vikram Sarabhai died young: the former at 56 and the latter at 52. Each was at the prime of life and one could have expected a decade or more of significant and decisive contributions from them. Each passed away from our midst suddenly leaving a void difficult to fill. Each of them belonged to well-to-do and well-known families. Each could have chosen commerce or industry for a career but decided otherwise and devoted themselves to scientific research. Whilst the early inspiration for Homi Bhabha and for Vikram Sarabhai was pure science, each became aware with the passage of time of the powers of science and technology as an instrument for social and economic changes. And without giving up their basic love for, and interest in, fundamental research, they looked for opportunities where science and technology could play a decisive role for the betterment of their fellow beings. Homi Bhabha put India

The First 25 Years

bove : (Left) Vikram at the age of 7. (Right) With ather Ambalal and mother Sarladevi and sister itaben, 1930

elow : At Cambridge, 1936. Right : (Top) With his ife Mrinalini, 1942. (Bottom) At the Indian nstitute of Science, Bangalore, 1944, with Dr. ubbarayon (later C. M. of Madras State)

PRL—a home for work

Prof. K. R. Ramanathan

Physical Research Laboratory, Ahmedabad

PHYSICS and mathematics were the main subjects of his interest. When he was about 17, he was sent to Cambridge where he took his Tripos in 1939. When the Second World War started, he returned to join the Indian Institute of Science at Bangalore to work under Sir C. V. Raman. His subject was the study of the time distribution of cosmic rays. Within three years, he was ready with his first paper (it was published in the *Proceedings of the Indian Academy of Sciences—A, Vol. 15,* 1942). Using Geiger counters and chronographic recording and appropriate statistical analysis, he had established that up to time intervals of 1/50 sec, there was randomness in the time variation of cosmic rays.

When the War was over, Sarabhai returned to Cambridge. The fields he had chosen — cosmic rays and particle physics — were still uncharted territories; these were subjects at the frontier of knowledge. A lot had to be done and he went ahead with his work. In 1947, he was awarded the Ph D degree of the University for his thesis on " Cosmic Ray Investigations in Tropical Latitudes ".

It was as early as 1942, when Dr. Sarabhai and his newly married wife, Sreemati Mrinalini, were staying for some time in Poona, that he had conceived the idea of starting the Physical Research Laboratory in Ahmedabad. Soon after his return from UK in 1947, Sarabhai started looking for a place. He talked to many people. Some were impressed. Shri Kasturbhai Lalbhai, Shri M. G. Mavalankar and other members of the Ahmedabad Education Society agreed to let him have a few rooms at the M. G. Science Institute to start the Laboratory. I had also agreed to join him early in 1948 as soon as I retired from the India Meteorological Department.

We started work with three or four research scholars, a glass blower, an office assistant and a carpenter-cum-mechanic. The funds required for equipping the Laboratory and meeting its day-to-day expenses came first from the Karmakshetra

on the nuclear map of the world; Vikram Sarabhai did it in the field of space.

Their contributions to these fields were also a natural outcome of their early work and interests in fundamental research. Homi Bhabha did outstanding research in the areas of high energy theoretical physics. With this background, he became aware of the possibilities of abundant cheap power in the form of nuclear energy. He was also aware of the tremendous need for power if India were to develop into a modern industrial society. He threw himself wholeheartedly into the development of nuclear science and technology.

Vikram Sarabhai's interests were in the use of cosmic rays as a tool for studying conditions in deep space. Prior to 1957, cosmic ray intensity variations were studied by means of ground-based equipment. These were done on a worldwide basis through international co-operative efforts such as the International Geophysical Year. It was well recognised that these variations were related to the state of interplanetary space and conditions on the Sun. Since 1957, with the coming of the Space Age, detector systems have been employed well above the Earth's atmosphere to make direct measurements in the ionosphere, in the magnetosphere, and even in distant regions of interplanetary space. It has become possible to study directly the magnetic conditions in these regions, the ejection of plasma by the Sun and the variety of phenomena which were contributory factors to the cosmic ray variations detected and studied earlier with ground-based equipment. Vikram Sarabhai was naturally interested in these developments and studied them deeply on the several occasions when he was Visiting Professor with Professor Bruno Rossi's group at the Laboratory for Nuclear Science at the Massachusetts Institute of Technology, where he had a standing invitation.

Space Age — a new age

Vikram was fully aware of the enormous potentialities inherent in space science and technology for a wide range of economic and social developments: in the areas of communication, meteorology, exploration for natural resources, as also in terms of the fall-out which would undoubtedly occur from the pursuit of the advanced technologies involved. He realised that the space age was a new age for mankind. It was not part of the continuum of human development. It represented a transition to a new era with new possibilities. And Vikram was determined that India should benefit from it and transform itself by understanding and working on these possibilities.

A remarkable characteristic of Vikram was the breadth and diversity of his interests, and the manner

Educational Foundation (a Trust of the Sarabhais) and the Ahmedabad Education Society, and later from grants from the Council of Scientific and Industrial Research, the Government of Bombay and the Department of Atomic Energy. The foundation stone of the new Laboratory buildings was laid in February 1952 by Sir C. V. Raman and the Laboratory was opened in April 1954 by Jawaharlal Nehru. Whatever the PRL is today, is solely due to his initiative, personal contacts, persuasiveness and supreme confidence that financial help would be forthcoming for a good cause and good work.

The PRL was his home ground. He had created it, nurtured it and he would come back to it to work, to teach and to write. In the midst of his heavy administrative duties, he would manage to squeeze time to do important scientific work in the field of cosmic rays and their temporal and spatial variations and their relation to geomagnetism, solar activity and interplanetary space. Between 1949 and 1971, 20 postgraduate scholars working under him have taken their doctorate degree and about 50 scientific papers have been published by him in international scientific journals, many of them in collaboration with his students.

in which he transformed ideas into institutions. Thus, he helped to found the Ahmedabad Textile Industries Research Association (ATIRA) which was to play a notable part in the efforts to modernise the textile industry. He served as honorary director of ATIRA from its inception until 1956 when a full-time director was appointed. Here was an example of applied research of direct interest to industry, carried out with the participation of, and on behalf of, industry on a co-operative basis. In 1962, he helped to found the Indian Institute of Management in Ahmedabad, since he felt that the rapid growth of India to an industrial power would demand management skills of a high order; from the time of its foundation he was its honorary director until 1965.

He was deeply interested in the possibilities of enlarging the horizons of school and adult science education and under the aegis of the Nehru Foundation for Development, he established and developed the Community Science Centre at Ahmedabad.

In the areas of space science and technology, he set up the Thumba Equatorial Rocket Launching Station, which under United Nations auspices, offers facilities to all nations in the world to conduct space experiments at low geomagnetic altitudes. Then he set up the Space Science and Technology Centre at Trivandrum and the complex associated facilities there, the east coast Sriharikota rocket launching range north of Madras and the Experimental Satellite Communication Station at Ahmedabad.

These were all in addition to the way in which he manfully carried on his shoulders the Atomic Energy Programme, since the passing away of Homi Bhabha in 1966, when he was asked to become Chairman of the Atomic Energy Commission.

Vikram Sarabhai's interests had expanded to the problems of world peace and disarmament. He was a member of the Continuing Committee of the Pugwash Movement and set up the Indian Pugwash Society.

But, above all he was a warm human personality, ever modest, deeply simple in his ways, soft-spoken and courteous, who worked right up to the end with an urgency which had to be seen to be believed, working against time as if he knew he had so much to accomplish. His passing away is indeed a grievous loss to India and Indian science and to all those who learnt to hold him in affection and respect, and who will in the years to come regard it as a remarkable privilege to have known such a person who had a shining vision of an India that would leapfrog into the future through the proper use of the powers and capabilities of modern science and technology.

Myths and Realities

COMMUNICABLE DISEASES

C. K. DESHPANDE

FOR a week annually, the banners go up. Across the highways and at public places, they read: " Eradication Week ". A week for each communicable disease. Malaria, yellow fever, rabies. Take any disease, we are out to clear it, root and branch. And ever since organised national and international efforts got underway to fight communicable diseases, eradication has become a popular slogan.

What have actually prompted these grandiosely sloganned plans are the successes in some advanced countries. Is global eradication of such diseases possible? At best they can be eradicated locally, provided the price is paid. But can the overburdened developing countries afford this price? No doubt, communicable diseases cause a great drain on the economy by the loss of livestock and human lives, often in their most productive years. But such losses must be weighed against the overall interests of the economy and the socio-economic conditions of a country.

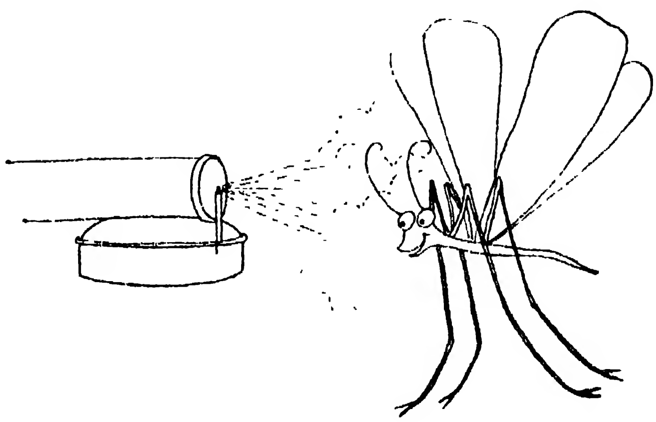
In diseases like rabies and yellow fever, monkeys and bats harbour the germs, giving them safe and inaccessible sanctuaries. Long before the rabies virus was identified, Pasteur had demonstrated the method of making a vaccine by introducing the virus from the street dog into the brain of sheep. Thus he produced an effective means of protection for man as well as dog, and it has been in use for over centuries now. And rabies is considered easier to control than many other diseases. It is caused by dog-man or bat-animal-man transmission. All we need to do is destroy all rabid dogs and protect all healthy ones by immunisation. This too has been done in a fairly thorough manner in the developed countries. In fact, some countries have strict rules about the import and maintenance of pet animals. Britain spends a large amount on quarantine for dogs.

Has rabies been eradicated? On the contrary. It is still a major problem in both developed and developing countries. Over 300,000 people are treated annually for rabies in India. The real cause of rabies, however, is not the stray dog. In India, it is mainly the jackal. The bat also is responsible for many cases. What makes the problem worse is that the bat lives in virtually inaccessible recesses as caves and thick forests, and it carries the virus without itself suffering from the disease.

Let us now look at a more familiar disease — malaria. Till a few decades ago, malaria was a dread scourge. It took millions of lives and sapped the energy of entire populations. It even made certain areas uninhabitable, forcing people to migrate to safer places. When, in 1958–59, the National Malaria Control Programme was switched over to the eradication programme, it was the first disease to be brought under this plan. And, for some time, it seemed to be quite successful too, raising great hopes in health workers.

The hope, however, did not last long. After what seemed to be an initial success, many states have now reported a rise in the number of malaria cases; from 1·1 lakh cases in 1966 to 4·2 lakhs in 1970. The non-availability of insecticides on time is the reason given in official circles for this setback.

None will deny that mosquito control by DDT and other anti-malarial drugs have kept the disease in check. But again at what price? After two decades of war against malaria, we now have the problem of new DDT-resistant strains of mosquitos. Ecological disturbances have promoted the rapid growth of culex mosquitos which threaten the same communities with the less manageable disease of filariasis.



The Health Survey and Planning Committee had noted in 1961 that certain risks were involved in malaria eradication. Insects other than the malaria vectors such as the flea vector of plague and sandflies transmitting kalazar have developed resistance to DDT. There have been cases of plague after a lapse of about 15 years. Meanwhile, the problem is getting more complicated: harmful levels of DDT are found in the food cycle following its indiscriminate use in many parts of the world and malaria is rearing its head again in some countries as far away as the US and Indonesia. In India the deadline to root out the disease has been shifted to 1976. And Rs. 108 crores will be spent in the next five years.

An impressive story

The control of tuberculosis in the USA makes an impressive story. Nearly 60 years ago, Dr. Welch of Johns Hopkins School of Medicine said: "It may now be stated that while all the problems related to tuberculosis have not yet been solved, we have an amount of information which enables us to state positively that if practical measures based upon this exact scientific knowledge are properly applied the cases of tuberculosis can be reduced to a relatively small figure." This was when neither streptomycin nor BCG was known. The disease was controlled by simply isolating the patients and creating clean and healthy living conditions. Tuberculosis declined in a dramatic manner in the US with an improvement in socio-economic conditions. Anti-tuberculosis drugs and BCG dealt the final blow. Yet even today, the US spends about Rs. 38 million on tuberculosis research. The cost of chemotherapy is a fantastic Rs. 5,500 million per year.

Can developing countries afford this? In our conditions of urban squalor, the incidence of tuberculosis is increasing at an alarming rate. The death rate from TB in Indian cities ranges from 1 to 1·5 per 1,000 population. For lack of adequate data, others put this at 2·5 to 5 in the urban areas and 1 to 1·5 in the rural areas. On a rough estimate, about 8 million people now suffer from TB. And of these, about 2 million are infectious. Though better medical facilities have brought down the mortality rate in some large cities, basically the situation is analogous to 18th century industrial England. BCG may be a good palliative, but as long as low resistance due to malnutrition and unhygienic conditions and overcrowding are inherent in our system, we will have a large number of people harbouring tuberculosis organisms in the quiet corners of their lungs or lymph nodes only to flare up in old age. Tuberculosis bacilli do not die easily.

How do we then approach the problem? Are we going to detect and treat each case or improve the general nutritional standard? The best solution will be to improve nutritional standards and build up enough physical resistance in the population. This will call for a massive effort against malnutrition and overcrowding. It may also guard people against many other infections.

Besides, in any disease, natural processes are always working towards a balance between the host and the parasite. This evolution is clearly seen in many diseases like syphilis and leprosy which run a more violent course when attacking virgin populations. Over the centuries, both these parasites have learnt "to live" in the host as ideal parasites, ones which do not kill the host. By necessity the virulent strain or any germ or parasite has poor chances of survival, and the presence of the germ in the body provides ideal immunisation. In diseases where live vaccine was used, success has been quite dramatic. A good example of this is small-pox. In the circumstances, eradication appears a distant dream. More realistic would be to think of "control", backed by a nutrition programme.

[Dr. Deshpande is Dean of B. Y. L. Nair Hospital and Topiwala National Medical College, Bombay.]

THE MIND OF THE COMMUNITY

A. P. PATKAR

IT happens with every war. There is a sudden emergence of unity; religious, political and economic differences are quickly forgotten and self-survival — of the individual as well as the nation — assumes the foremost importance. It happened during the recent 14-day war; the post-war sequelae will continue to be felt for some time to come. Is this social behaviour a natural process? How does society behave under conditions of stress and strain? A society is the sum total of individual families coming together on the basis of religion, occupation or economic considerations. It is at this level that our studies must begin.

In fact, the considerations are primarily of health, — both mental and physical. Physical health can be taken care of, relatively easily. Most of the known infectious diseases can now be prevented and easily treated. The time may not be far off when cancerous conditions will also find a cure. Only two major problems of human illness may remain: *1*) post-traumatic injuries of various types, and *2*) psychological or mental illnesses. The former is already on the research table with promises of success. What still looks formidable is the other problem — mental illnesses and their prevention.

The concept of mental health didn't exist until a few years ago. Then several rapid breakthroughs occurred in the treatment of mental illnesses by drugs and physical treatments like electric convulsive therapy, insulin therapy, surgical procedures on the brain, occupational therapy and psychotherapy. It was but natural that psychiatrists would start thinking in terms of people as a group, especially because with newer technologies and rapid industrialisation, there is an ever-increasing conflict between the individual and the community. With this in mind, the Royal Medical Psychological Association of England had arranged a programme under the chairmanship of John Sutherland wherein psychoanalysts, social scientists, anthropologists, psychologists, and psychotherapists participated. The papers presented are being collectively published under the title *Towards Community Mental Health.**

The book opens with the paper on " The Concept of a Healthy Individual " by D. W. Winnicott, a Freudian analyst and child psychiatrist. Nobody has yet been able to define a healthy individual. Winnicott begins with the early infant relationships, maturity with age, importance of anogenital zones, cultural influences, etc. These are age-old Freudian concepts which have undergone tremendous modifications by Jung, Adler, Eysinck and others. A healthy individual has three lives:

1. Life in the world with interpersonal relationships including use of non-human environment.
2. Life of the personal psychical reality, wherein people are richer and deeper (in emotional experience) and creative too.
3. Cultural experiences of the individual.

These three compartments which Winnicott has created are so interwoven and interdependent that hardly any psychiatrist will attempt to separate them. Even the milestones of psychosexual development, e g the oral phase, the anogenital phase, the haterey phase, the homosexual phase and finally the heterosexual phase (full maturity) have been known to be variable and dependent on the environment. The concept of health as the absence of psychoneurotic illness is misleading since it does not make anybody wiser. A more positive definition is called for. This very negativism in thinking, verbosity and jargon has kept the field of psychoanalysis away from an average person. I am no wiser, after reading this paper, as to what positive steps could be taken towards establishing and improving community mental health.

In the second paper, Elizabeth Bott, a psychoanalyst, discusses " Family and Crisis ". She compares the relative merits and drawbacks of the ' family ' in England with the ' family ' in Tonga. The Tongan family, I assume, will be identical with an average Indian family, either in our villages or in chawls in cities. The Tongan family is composed of relatives, friends and neighbours. Everybody knows everybody else. Everybody's happiness and sorrow are shared by everybody else, because of the continuity of relationship. A Tongan family is apt to receive a lot of help during crisis, e g a death in the family, severe mental or physical sickness, pregnancy, etc. As a result, a young westernised Tongan girl remarks " when you leave Tonga, you feel free, when you reach England you feel lonely". This loneliness, though it follows a certain measure of independence, also causes despair, mental illness and suicide. A western family, Bott

*** *Towards Community Mental Health.* Edited by John D. Sutherland : Tavistock Publications (1971) £2·40**

points out, is not contained within a larger group but only loosely connected with the networks of society through its individual members. There is no unity or identity of purpose or values. The causes, according to Bott, are overindependence, easy break-up of family ties, financial security provided by the industrialisation and overcrowding in the towns and cities.

It is also interesting to note how differently a western and a Tongan family would react to the occurrence of a mental illness in the family. In the western society, mental illness still carries a stigma, with the resultant delay in seeking psychiatric help. With the enlightenment of the family about mental illnesses, thanks to TV, radio and the press, the western family begins to brood: "Are the children tainted with mental illness?" "Am I such a bad child as to drive him mad?" "Is it going to happen to me?" "Why him and not me?" "Thank God, it is him and not me". It may lead to a lot of guilt-feeling, precipitating illness in the family members. In the Tongan or an Indian family, the response would be different. First, the patient would be taken to a spiritualist to remove black magic, to the temples to remove a black curse and ultimately to a psychiatrist within a short spell of time. No brooding over heredity, guilt or stigma.

Children and education

"Only some one who can feel his way into the minds of children can be capable of educating them, and the grown up people cannot understand children because we no longer understand our own childhood" — this is what Freud wrote in 1951. Ben Morris, in his paper "An Educational Perspective of Mental Health", more or less echoes Freud's thought. The educational profession, and the other professions like medicine, psychology and sociology should work hand in hand in the development of the child. The childhood years are the most impressionistic years and teachers, if they have no insight into the psychological development of children, are likely to do more harm than good to their young minds. They may set impossible tasks or fail to sort out the retarded or maladjusted ones from the lot. Behaviour and neurotic problems may assume a sinister proportion leading to delinquent tendencies which later become a burden on the family, society, legal profession, police and the state. Education does not consist of merely completing tasks from textbooks but must also develop the capacity to deal with both internal conflict and external stress. The notion of discipline, so dear to the heart of most teachers, must not strangle and obscure the productive relationship between teachers and students.

What are the remedial measures? According to Ben Morris, an immediate reorganisation of the examination system. At present, examinations control teaching which should be in fact be the other way round. And teachers should be prepared for an entirely new concept of their responsibilities regarding what should be taught and how it should be taught. And the problem students should be handled by the combined force of the teachers, parents, psychiatrists, psychologists, social workers and schools counsellors, all of whom have special training in human understanding.

Industrial psychology

Elliott Jaques, professor and head of the Department of Social Institutions, University of London, in his fourth paper on "Social Institutions and Individual Adjustment", details his observations on industrial psychology. Working as a social scientist in a large industrial company, he researched in all areas of organisation and management, e g executives, trade union relations, level of work measurement, payment structure, individual progress, appeals procedures, accountancy, management training, sales, production, etc. He noticed that overlapping of the responsibilities of various departmental heads with no central supervisory or advisory authority leads to a chronic competition between all of them. Failures to keep to the production schedule were ultimately blamed on the managers who tended to complain of fatigue, overwork and who ultimately resigned. Jaques had solved the problem by departmentalisation with a separate authority for each head who in turn was responsible to the central head — the works manager. Thus the essential principle was building up an organisation in which members were actually accountable for what they were stated to be, in the sense of their responsibilities being consistent with each other over having sufficient authority for their work. This led to job satisfaction — the central dynamic force which improves the performance of industry. In the epidemology of mental illness, he quotes from Paris and Bunham (1965) from United States where schizophrenia is significantly more prevalent amongst the working class as against depression amongst the middle classes. He shows from different social studies in the US and the UK that poor economic circumstances in modern industrial urban conditions lead to severe mental illnesses like schizophrenia. The most likely explanation in his view is neglect — emotional and physical — of infants and children because their mothers have to work or are financially harassed.

Although "The Congruent Society" by Geoffrey Gover, a social anthropologist, makes fascinating

reading, it is doubtful how much it can really contribute towards community mental health. He states that all values — moral and material — are determined by the culture and institutions of the society and vary from place to place and time to time. Similarly, patterns of neurotic or psychotic breakdowns also depend more on the society and the culture than on the individual. All our values are culturally determined and cultural values depend on social institutions.

Take for example, "falling in love" as a prerequisite for marriage in western society. After a certain age, heterosexual attraction, leading to falling in love and consequent marriage are the three 'normal' modes of behaviour of every young person. If a young person does not exhibit the above process, it may, rightly or wrongly, worry the parents and the person may be brought in for psychotherapy. The psychiatrist (influenced and reared up in the western culture) may also be immediately biased in terms of illness and psychotherapy for that person. In our society, on the other hand, falling in love is not an essential process before marriage and parents are not worried if their ward does not 'date'. Again, 'falling in love' does 'make' a marriage but it can also break a marriage, if one of the married partners falls in love with somebody else.

A guilt society

Anthropologists distinguish cultures according to the psychological mechanisms governing the individual and social behaviour, ie sense of sin, sense of shame or pride or sense of guilt. An example where the sense of sin has been used to control individual social behaviour is Russia. If one is right — at that particular time — he is worshipped and raised to a high pedestal — only to fall after some time and branded as a sinner. If one is wrong, he is immediately ridiculed into submission and oblivion, though later on he may be praised and worshipped.

Again, take the primitive societies. A young man can prove himself by murder, by taking an enemy's head or a scalp. Yet he cannot be described as sociopathic — as he would be by our standards — since it does not involve conflicts with his own society.

Cultures incorporating the sense of guilt usually set up unattainable standards, particularly so in order to make an individual stretch himself as far as possible. Such "collective stretching" may lead to the advancement of society. Constant guilt feelings produced by the parents in their children (say, about studies) or by the boss in his employees (say, about work output), may be the predeterminant of neurosis because no matter how hard the individual tries, he is never praised. In fact, he may be discredited in order to extract some more out of him. Similarly, the guilt-based society has its inherent 'splitting', because internal values of behaviour based on parental imperatives may be at variance with values and standards of behaviour demanded by the institution. Take, for example, the massacres in Vietnam. A country which encourages equality and is based on Christian ethics in civilian life could encourage or produce soldiers capable of callously murdering people of all ages and sex. This could be the 'split' of the mind — civilian and military.

Mental health in India

After studying some aspects of community mental health, particularly in western countries, it is natural that we consider the problems in our own society. The problems we have are very complex indeed, being a large country with diverse languages, religions, poverty, poor resources, lack of trained or skilled personnel, overcrowding with overpopulation, etc. Before you can start tackling problems of mental health anywhere, there should at least be a rough statistics available to make a start. In that sense this 'first' report** on the statistics of mental health makes an encouraging beginning. It includes the information on morbidity and mortality patterns, facilities and services available and personnel employed in mental institutions for the treatment of mentally sick during the period 1947–1969. Some salient features of the report are:

(1) Morbidity surveys conducted in some selected areas in India indicated mental morbidity rate as 48 per lakh of population.

(2) In Maharashtra, 89 per cent patients treated in mental hospitals suffered from psychosis — a major mental illness.

(3) Mental illness was most common amongst the poorest — 89 per cent of the inpatients belonged to the income group of Re. 1 to Rs. 100 per month.

(4) There were 38 mental hospitals in India in 1969, with 17,916 beds.

(5) There were 10 child guidance clinics in mental hospitals.

(6) Provision of Rs. 50 lakhs (!) has been made in the Fourth Plan for setting up 40 psychiatric clinics in the country.

The incidence of mental illness in India is said to be 2 per 1,000 of population as compared to the USA's 5 to 8 and the UK's 3 to 4 per 1,000. Those afflicted with mental illness include not only the

** *Mental Health in India* by S. K. Sen Gupta and D. R. Chawla. Issued by Central Bureau of Health Intelligence (1970)

obvious mentally sick persons, but also neurotics, the mentally retarded and physically ill persons (e g high blood pressure, peptic ulcer, certain skin conditions, bronchial asthama or some other psychosomatic problems) and criminal offenders, juvenile delinquents and the suicidal. The exact magnitude of the problem is very difficult to judge as no reliable statistics are available in our country due to the paucity of staff and lack of systematisation. Yet the problem is mounting day by day and we have to watch on helplessly. The sanction of Rs. 50 lakhs on 40 clinics, i e Rs. 1–1/4 lakh on every clinic, during the years 1969–74, is like a drop in the ocean. It only satisfies the guilt complex of the authorities that "something is being done for the mentally sick". Merely establishing a few more mental hospitals or clinics is not likely to cause any improvement in our care of the mentally sick. What should be done is to:

1. Improve and establish diagnostic and treatment facilities in the community itself. Accepting the fact that a small proportion of mental illnesses are incurable and that the patients may have to remain in a mental hospital all their life, a majority of these cases can be and should be treated in the midst of their home atmosphere only. With modern treatments, violence and unco-operativeness quickly disappear and patients can be put back to work soon. There is no stigma of mental hospital admission and no formalities for admission or treatment. Since patients are looked after at home, there is no economic burden on the state. This can be easily achieved by establishing more psychiatric departments in all hospitals, where patients could be admitted, for a short time if necessary, and discharged quickly. Even the British health authorities have shifted the emphasis from mental hospitals to such departments and day hospitals (or night hospitals, if the patients are working during the day).

2. More training facilities for psychiatrists, psychologists, social workers is urgently needed. Due to the acute shortage of trained professional men, heavy burden is put on them which leads to lowered standard of work. Regular psychiatric training should be made a part of the curriculum for teachers, the legal profession, the police, prison officers, etc whereby they will have at least a partial insight into the problems they deal with.

3. People, ignorant as they are, should also be made aware that mental illnesses are like other physical illnesses and are also easily and speedily curable. This can be done by press, radio and TV publicity so that these patients can be brought in for treatment as early as possible.

4. School psychiatric facilities for consultation and easy treatment of problem children should be instituted. By making psychiatric services easily available in the vast number of schools, parents and teachers can easily discuss the problem in school settings. Early detection and treatment at this level can easily prevent a lot of sufferings later on, both for the students and the parents. This service should be treated as prophylactic as well as curative.

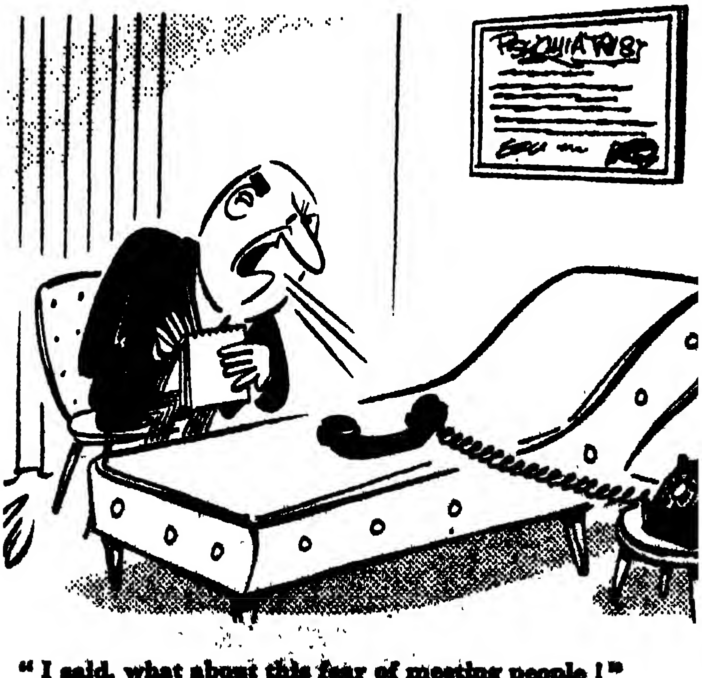
5. The problem of mentally defective children has hardly received any attention at all. There is an urgent need for both training schools as well as institutions for these unfortunate people.

6. Establishing child guidance clinics not in mental hospitals as the report envisages — but in the community itself, i e in general hospitals, in community centres or in family planning clinics or at any other place within easy access.

7. Mental hospitals as they stand today are worse than dangerous. They need to be urgently redecorated, expanded and modernised.

With more and more research that is being done, particularly in western countries, our understanding of the brain and the mind is increasing rapidly. Psychiatry is a recent science. Yet it has done a lot in the last few decades towards helping those mentally sick patients who would have been given up for lost.

[Dr. Patkar is a consulting psychiatrist, who is also attached to the Topiwala National Medical College and B.Y.L. Nair Hospital, in Bombay.]



"I said, what about this fear of meeting people!"

Beating Back the Cold

A thin layer of air around the body shields man from the cold. But this shield can also carry germs of infection

ON that cold December day in London, one of the men at the National Institute of Medical Research attracted a lot of attention. With his protective clothings and the several watches strapped on his hand like an instrument panel, he looked almost like an astronaut at a training session. Some of the watches had stopped ticking; but the man didn't seem to be particularly concerned. He went about his work quietly. At the end of the day, he stripped off the watches, put them down on his table and started studying the timings.

What was the man doing? He was, in fact, a subject of a study of how the body survives the cold. Man functions most efficiently in ideal climatic conditions. Too much cold or too much heat causes discomfort and impairs efficiency. Though protective clothes can help, they also cause much inconvenience. And if scientists could know how exactly the body keeps away the cold, they could use it ergonomically to create comfort and efficiency in extreme climates.

The human body is wrapped in a microenvironment — a layer of air circulating around the skin and buffering the body from the external environment. The formation and the movement of this layer and how it protects man from the cold is what scientists at the London Institute are studying. And since the meteorological environmental data refer to heights above six metres from the land, they had to devise new methods to study the environment up to 1·5 metres — the average height of man — above the ground. One such method was temperature-sensitive watches. Individuals wore several of these watches pre-set to stop at different levels of cold. By reading the dials at the end of the day, it could be determined how long the individual had exposed himself to various temperatures.

This, and some other methods, however, established the environmental climate, but not the microenvironment itself. The body perceives the environment through receptors in the skin. Normally warm clothes keep off some of the cold; and men also seek comfortable shelters in extreme climates. The normal temperature for bodily comfort is 33°C, and the temperature at the core of the body is 37°C. That gives a gradient of 4°C from the core to the skin. From there the gradient is steeper. More so when it is too cold outside, say, − 60°C in England and 5° to 0°C in some Indian cities. Clothing reduces this gradient as it traps air near the skin and between its folds. The ideal polar outfit would therefore comprise several layers of light garments, the outermost being windproof to retain layers of relatively still air. The fabrics should be permeable to water vapour so that sweat can evaporate. Sweat-logged clothing becomes impermeable and leads to a rapid depletion of body heat. The skin, which is relatively thermoneutral when directly exposed to the environment at 25°C to 29°C, responds to temperature fluctuations by increasing (vasodilation) or decreasing (vasoconstriction) the blood flow near the surface. Beyond this range, other mechanisms are triggered — a rise in temperature leads to sweating, a fall leads to shivering.

How can we measure the temperature next to the skin? The scientists designed a special string vest, knitted from a continuous length of plastic-coated wire which registered any change of temperature as a change in electrical current. And studies showed that the microenvironment differed from the meteorologist's environment. The temperature here was around 30°C to 33°C — the range for human comfort — because of protective clothing and shelter.

The microenvironment is then probably a structured layer, the scientists thought. Since its temperature was higher than the room temperature, the scientists turned to an optical system (used in aeronautics for visualising shock waves in high-speed wind tunnels) which showed differences in density. In the case of the microenvironment, densities can be increased or decreased through variations in heating, and such differences identified. The 'schlieren' optical system, originally developed to detect flaws in optical glass in Germany, was used. When a man stood in the area of the schlieren system (see picture on p. 51) the warmed air next to his skin showed up in marked contrast to the cooler room air. Any part of the human body could be studied by illuminating it with the schlieren beam.

Observations revealed that the air layer around the body was not still but moved constantly upwards. It breaks away from the horizontal dorsum of the foot, then holds close to the skin on the leg in a 1–2 cm thick flow. At the chest level, the outer layer of the flow becomes turbulent and breaks up, but the flowing sublayer remains. The face and head contours modify the flow. The undersurface of the chin deflects the flow mainly up the sides and

front of the face. In the side flow, the pinna of the ear acts as a streamline and carries away most of the warm air, leaving a little to flow around the head. On the face, the layer passes up the chin, over the lips and is inspired through the nose with the ambient air, thus entering the respiratory cycle — it accounts for about 10 per cent of each tidal inspiration. Expired air is directed as a jet beyond the area of inspired air. The flow continues to the forehead, rising in a plume for about 50 cm, after which it breaks up and mixes with the air in the room.

The temperature gradient from the skin to the air outside determines the heat transfer which in turn determines the movement of air. The larger the air movement, the greater is the heat transferred. So the scientists investigated the relationship between the schlieren figure and the velocity/temperature profiles outwards from the skin surface. Using small thermocouples (to avoid disturbances in the air flow) and hot wire anemometers moved slowly to and from the skin, it was found that the maximum velocity in the laminar flow occurred about 5 mm from the skin.

The schlieren optical system

Twenty mm from the skin, the velocity of the air flow is the same as the ambient air. Schlieren photographs record the laminar flow up to 7 mm from the skin. For the turbulent flow, it can visualise up to 9 mm including all the velocity and temperature phenomena.

The fact that the microenvironment shields the body from the cold was clear. The next stage was the study of heat transfer from the body. Does the air flow carry particles and microorganisms from one part of the skin surface to another? Using a specially designed suction nozzle placed on the skin, air from the microenvironment was drawn out. The nozzle had a millipore filter, which was removed after suction and placed in a nutrient culture medium and incubated. After 24 hours, the culture showed that the microenvironment had four times as many microorganisms as the ambient air.

How did the microorganisms get there? Scientists think they entered either from the interface of the skin and the microenvironment or from the interface of the microenvironment and the ambient air. The pollutants and particles in the ambient air might have been captured by the air layer. Besides, the skin sheds keratinised flakes as it renews itself. The keratin enters the ambient air, carrying with it microorganisms and thus spreading infection.

When keratin flakes were scratched off from the skin and trapped in the sample, it showed 13 times more organisms than in the ambient air. In natural circumstances, the situation is almost similar; clothes constantly abrase the skin, flaking off keratin harbouring microorganisms which are transported by the microenvironment. Clothes also trap air and produce a bellow effect which results in high-velocity local gusts. These blow off keratin and lead to the spread of microorganisms even if the individual is at rest.

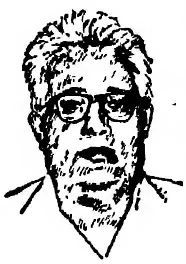
Bacteria can be transported through dust particles or contained in gross droplets expelled during coughing or sneezing. A more important source of the spread of microorganisms is bedmaking and undressing indoors. But the number of organisms per unit volume of room air is too low to reach an operating theatre or to infect a person by random contact. Direct aerial infection too is unlikely. This means that there might be some mechanism which can concentrate these organisms.

Particles as large as 10 to 50 microns from the ambient air can be entrained on the boundary of the microenvironment. The pattern of flow of this air layer takes the particles to the nose where the air is being inhaled. Thus it is not unlikely that pollutants can be concentrated and carried to the nose.

LOOKING BACK . . .

BOSE (1 Jan 1894): Satyendranath Bose's name is closely associated with that of Einstein. Born in Calcutta, Bose's two, and probably the only two, significant contributions to the growth of modern science are his statistical theory developed in collaboration with Einstein and his independent researches on the Unified Field Theory originally propounded by Einstein as a feature of his General Theory of Relativity. If the first freed the Maxwell-Boltzmann technique of a discrepancy, the second dealt with the field equations, which Einstein was unable to solve.

Essentially a theoretical physicist and concerned more with the mathematical problems of physics, Bose was intrigued, at an early age, by the failure of Maxwell-Boltzmann statistics in working out aggregates of more elementary particles (like photons and electrons) of nuclear physics. Bose amended the technique in consultation with Einstein, and the result was Bose-Einstein statistics, " a branch of statistical mechanics used with systems of identical particles which have the property that the wave function remains unchanged if any two particles are interchanged ". There cannot be any distinction between the individual photons. And the B-E technique recognises the fundamental indistinguishability of photons and electrons. So the elementary particles that " conform to B-E statistics such as photons and mesons whose numbers are not conserved in particle interactions " are termed " bosons ".



Bose's second achievement was to remove some of the difficulties in the Unified Field Theory, a by-product of the General Theory of Relativity. The theory seeks to explain electromagnetic, gravitational and subatomic fields in one set of laws or equations. Einstein had been trying to do this for long after the acceptance of his equivalence thesis. Bose's interest was aroused, almost simultaneously, by his involvement in statistical research in the early twenties. And both completed their search in the mid fifties. However, neither Einstein's nor Bose's work created any stir or even enthusiasm among scientists. Maybe, the result itself had become a little irrelevant because of some more useful, and relevant, discoveries in nuclear physics.

BOYLE (15 Jan 1627): Following the early Greek philosophers, natural science was still a theoretical philosophy in the early 17th century. Experimental verifications were considered unnecessary. The English chemist Robert Boyle belonged to the " Invisible College ", a periodic gathering of experimentalists, led by Francis Bacon, who refused to go by mere authority. (The college eventually became the Royal Society.)

Boyle applied the experimental philosophy to the study of material substances, and thus founded modern chemistry. His famous experiments on air established Boyle's Law — the volume of a gas decreases proportionately as its pressure increases; if the pressure is doubled, the volume is halved. But more important, it showed that air was compressible, and so made up of particles separated by vacant space. The atomic theory that matter is composed of atoms in different arrangements and motions got a boost and grew steadily therefrom.

With the help of his assistant Robert Hooke, Boyle built a vacuum pump and showed that all objects fell with the same velocity in vacuum; Galileo was proved right. In his *Sceptical Chemist*, Boyle defined elements as substances which cannot be broken into simpler forms, but can be combined to form compounds and separated again. Elements can be identified by chemical analysis. In physiology, advancing the work of Harvey, Boyle showed that the change from the dark red blood in veins to the bright arterial blood in the lungs was because of " the uptake of part of the air ". Boyle died on 30 December 1691.

FRANKLIN (17 Jan 1706): Scientist, statesman and writer, Benjamin Franklin of Philadelphia, USA, gave colonial America an intellectual status in Europe during the Age of Reason. With his famous kite experiment, Franklin proved lightning to be of an electrical nature.

Static electricity had just been produced. Large quantities of electricity could be stored in the Leiden jar, a glass jar with a metal lining and a metal rod kept in place through a cork. Held near a metal piece, it produced a spark across the gap with a crackling sound. This set Franklin thinking; couldn't thunder and lightning be a gigantic electric spark leaping across the gap between the earth and the sky? The hypothesis had to be tested. Franklin made his famous kite. It had a pointed wire, and a silk thread—an electric conductor—was tied to it with a metal key at the other end. And when, flying the kite in a thunderstorm, Franklin held his hand near the key, there was a spark! Since it was observed that the Leiden jar gave bigger sparks near a pointed wire, Franklin suggested that pointed metal rods, placed on roof-tops and, connected to the earth through wires, can absorb and conduct the electricity safely to the earth. Soon lightning rods stuck out of several Philadelphian roofs, avoiding much damage.

Franklin worked out the theories of electricity, though not very accurately. Their basis was the presence of an " imponderable electric fluid ", permeating all space and material bodies. These bodies were " electrically neutral when the concentration of the fluid within them

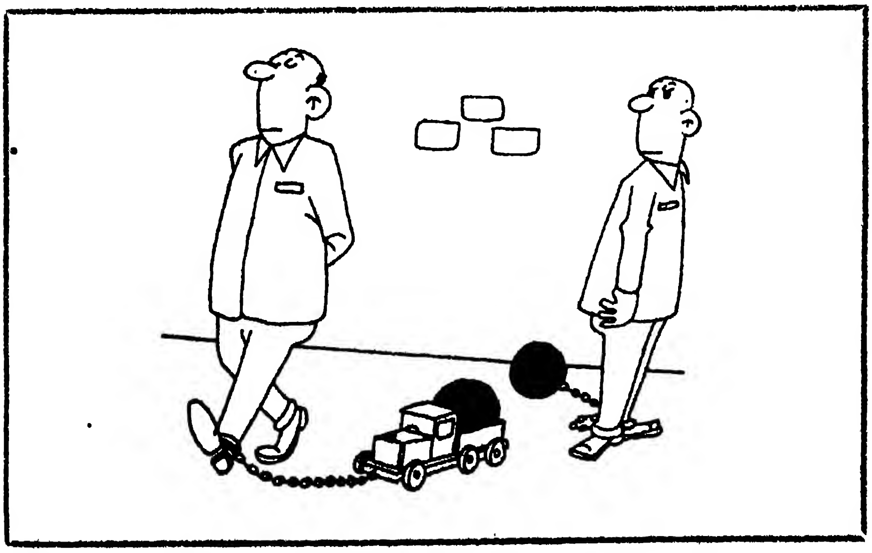
and outside were the same. An excess of the fluid rendered the body positively charged, whilst a deficit rendered it negatively charged ". Two bodies with an excess of the fluid or two bodies with a deficiency repelled each other. But a body with an excess attracted one with a deficiency; the excess fluid flowed across the gap to fill the deficiency. Hence the spark and the crackling, though not in every case. Later physics, however, showed some flaws in this theory — that electrons are the source of electricity (J. J. Thomson) and that the electrons flow from the negative terminal to the positive. Franklin died on 17 April 1790.

WATT (19 Jan 1736): The common man remembers him only while buying an electric bulb. But the Scottish mechanical engineer, James Watt, was not satisfied with merely putting scientists' suggestions to practical use. Before building or repairing an instrument, he learnt its theory and operation.

Watt's chief contributions were the invention of the modern steam engine using a separate condenser for steam economy and the development of a double action piston. Newcomen had first built the steam engine; but the device was inefficient as steam was condensed in the piston cylinder itself using a jet of water, and the cylinder had to be heated up all over again for the next cycle, wasting much time and energy. Watt built a second chamber, kept constantly cold, for condensing the steam, while the first chamber, the cyclinder, was kept hot. The process went on efficiently, and the new engines soon replaced Newcomen engines. Watt then improved the engine by letting the steam enter alternately on either side of the piston; this moved the piston both ways rapidly, unlike in the earlier engines. Using wheels, Watt converted this reciprocal motion of the piston into rotary motion. Here then was the first " prime mover ", which used natural fuel to produce mechanical motion. The device soon found several industrial applications. And the Industrial Revolution began.

Self-taught, Watt also invented the centrifugal governor to regulate the steam output of an engine. Seeking to measure the power of a steam engine, he experimented with strong horses and found that they could raise a weight of 150 lbs about 4 feet in a second. ' Horsepower ' has since then been standardised at 550-foot-pounds of work per second, equivalent to about 746 watts; or the kilowatt is about 1·5 hp. The ' Watt ', a unit of electrical power necessary to maintain a current of one ampere under a pressure of one volt, was named in his honour.

While an ink for copying manuscripts, an apparatus to reproduce sculpture and another to measure distances between the planets and stars are among Watt's other inventions, his discovery that water is a compound of oxygen and hydrogen put him in the ranks of fundamental researchers in spite of rival claims by Cavendish and Lavoisier. He died in Heathfield, England, on 19 August 1819.



AMPERE (22 Jan 1775): Many of the appliances that are based on electromagnetic devices today owe their existence to the French physicist and mathematician Andre Marie Ampere's original discoveries. As early as the third decade of the last century, he predicted the electrical nature of the atom in his theory that " magnetism in a permanent magnet is the result of molecular electricity ".

Ampere's main field was electrodynamics and his major discoveries were about the effects of the flow of an electric current.

According to the Danish physicist Oersted, a pivoted magnetic needle turned at right angles to a conductor carrying a current. Ampere formulated a rule (Ampere's Rule) for straight conductors, showing the direction and the circular shape of the magnetic field produced by a flowing electric current. The rule also predicted the way a magnetic needle is invariably deflected at right angles to straight-wire conductors. Ampere proved that when the current flowed parallelly in the same direction, there was a force of attraction while there was a force of repulsion when it flowed in opposite directions. In an exact mathematical form he also fixed the relationship between the electric currents, the distance between the two wires and the forces of attraction and repulsion. About circular conductors, Ampere discovered that the strength of the magnetic field increased with the increase in the number of turns of the wire, and that at each open end of the coil there were opposite magnetic poles. The electrical unit of current strength is named after him, and the electrical instrument for measuring the current is named ' ampere meter ' or ' ammeter '. Ampere died on 10 June 1836.

S. N. Munshi

HEDGEHOGS

WOBBLING along its path at dusk a lonely little animal suddenly halts, sniffs the air and pricks its ears, sensing something unusual. Though capable of considerable speed, the escape instinct which makes other animals flee to cover seems lacking in the hedgehog. It stays rooted to the spot and puts its defence mechanism into action. This begins with a frown — almost showing the world how angry it is — which deepens, a drawing in of the head and a bristling of the spines along the neck. If the enemy is still bold enough to advance, it erects all its spines and draws in its limbs, ready to flick into a spiny ball. It's only when the foe is uncomfortably near that it rolls into a ball with all the soft and vulnerable parts drawn in tightly. The prickly ball is enough to deter most foes.

The hedgehog's spiny armour is not as cumbersome as it seems, nor is defence its only function. The spines are modified hair covering the neck, shoulders, sides and back. When the spiny coat meets the fur which covers the rest of the body, the transition phase between fur and spine is distinctly visible. The spines are about three cms in length in an adult. From counts on three specimens, their distribution was calculated at 94 to a square inch. Each spine is marked with longitudinal ridges, which in some species has saw-like teeth. At the base where it enters the skin, it narrows forming a neck which makes it flexible. The part within the skin is enlarged to a globular shape. The spines can be raised at will by longitudinal muscles lying underneath.

At birth the hedgehog's body is marked with pimple-like projections from which, two days after birth, the spines protrude after the skin has lost water. This perhaps reduces discomfort to the mother during birth. The first set of pale soft spines are few and distantly placed. They are supplemented with a second, darker coat of spines. The third denser set which replaces these two begins to grow at the age of four weeks. The adult spines are dark in the middle (black or dark brown) and light at the extremities (pale yellow or white). Each spine is so firmly embedded that the animal can be lifted by a single spine.

In addition to being a defence coat, the spines act as a buffer when the animal falls from a height, deliberately or otherwise. The hedgehog, aware of the spine cushion, rolls into a ball and rolls down slopes or drops vertically from trees or walls instead of descending in the conventional way. Some of them attack by poking their spines into the enemy. Others erect their spines, arch their back and jump up, hurting anyone in their way.

Folklore and pottery dating back to 2000 BC depict that hedgehogs gather fruits (especially apples) by rolling on them and impaling them on their spines. Though this has been discredited as old wives' tales, the hedgehog has been noticed rolling on fruits and impaling a few on their backs. In fact, this sequence has even been photographed.

The hedgehog is a sworn enemy of snakes and has a unique way of killing them. On scenting a snake, it tracks it down, nips its tail, inducing it to strike. But before the snake turns round to take action, the hedgehog bristles up and rolls into a ball and the stupid reptile is painfully caught and pierced

Left: An ordinary hedgehog. Right: The long-eared hedgehog (a desert species)

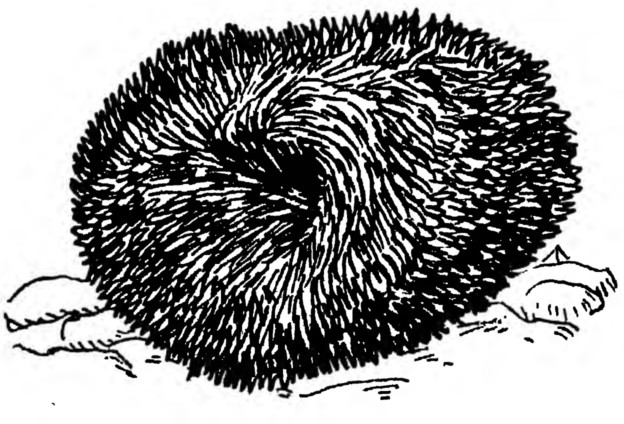
by the prickly back. It disengages itself only to entice the snake into striking again and again till fatigue and injury make it an easy and delicious meal. They can deal effectively with poisonous adders too.

The hedgehog is not the only one in the animal world endowed with a prickly coat. The porcupine is another and is often wrongly called a hedgehog. The two are in no way related. The porcupine belongs to the rat family whereas the hedgehog belongs to the insect-eating order which includes moles and shrews.

The four genera (five according to some authorities) belong to the order Insectivora, family Erinaceidae and sub family erinaceinae. They are found all over Africa except in the marshy, extremely wet parts, in almost the entire European continent and in practically the whole of Asia excluding south China, Burma, the Indonesian islands and Madagascar.

Being a day-sleeper, the hedgehog walks out at dusk in search of food. Though it is classed under Insectivora, it is really omnivorous. The range of its menu is indeed vast mainly because it has a high immunity to many poisons including corrosive sublimates, cyanides, opium and even snake poisons. Besides, it is 70 times more resistant to diphtheria than a guinea pig of the same size and 100 times more resistant to tetanus than man. But strychnine and morphine prove fatal. Its menu ranges from insects, worms, slugs, frogs, lizards, snakes, eggs and young of wild birds and small mammals to fruits and roots. Hedgehogs have often been falsely accused of thieving hens' eggs but it has been shown that hedgehogs are at a loss as to what to do when presented with one, mainly because eggs are too big for them to deal with. However, stray individuals learn to break and relish eggs. The second complaint was that it drank the milk from

Hedgehog—curled up



cows depriving men of their share. Experimentally it was shown a hedgehog could suck from the artificial teats which are used to feed calves. *Veterinary Review* recently reported such a case, showing photographs of lacerated teats. What lends credence to these cases is the fact that lacerations are seen only in summer and spring when hedgehogs are active and not in winter when they hibernate. But it is rather difficult to believe that a cow would submit to being painfully milked by a prickly beast.

Last but not least, the hedgehog is known to kill and eat its young when ill or disturbed. The sow often has to protect her young from the boar. In captivity, it does not harm others but if suffering from dietary deficiencies, it will consume the carcass of its fellows. In spite of the long list of edibles, the hedgehog can brave hunger and thirst for weeks at a stretch. Most of the feeding is done from dusk till past midnight after which it rests for a few hours before it begins feeding again till dawn.

Sleeper and hibernator

The day is spent in sleeping in hedges, or burrows and in the open if it is too warm. It lies stretched out, for most of its sweat glands are situated on the abdomen. It's only during their winter sleep that they curl up.

As autumn draws to an end, the hedgehog builds and furnishes its winter home or hibernaculum. This is a burrow lined with abundant leaves and moss. As the hedgehog usually turns round and round on the spot where it will lie down, the leaves are arranged layer upon layer. Its well-sheltered home is fairly weather-proof. From October when the temperature drops till March or early April, the hedgehog curls up and sleeps. Some hedgehogs sleep through till spring while others wake intermittently. Just before hibernation, lymph accumulates in the tissues. Nine out of ten white blood cells go to the stomach and the intestine to stop infection which may arise from leftover food particles. The rate of metabolism, heart-beat rate and body temperature fall, reducing the energy requirements of the body. The outermost parts are almost dead cold, getting warmer towards the interior with the heart retaining most of the heat. Within the hedgehog's body is a gland called the hibernating gland or brown fat. It is located near the shoulders. Another type of fat called the white fat acts as an insulating agent and replenishes the brown fat as it diminishes. The brown fat, however, has many fat droplets per cell (the white fat cells have only one fat droplet) and produces 20 times more heat at a faster rate. It acts as a thermostatically controlled electric blanket,

producing more heat as the temperature drops. When the temperature falls below the danger point, the brown fat produces more heat which activates the heart and arouses the animal from its slumber to look for a warmer and safer place. In spite of its long, deep sleep, the hedgehog responds to sounds by raising its spines. Spring comes in with a magic touch to awaken it and send it about its normal routine.

It breeds twice a year (thrice in hot climates) between May and July and August and September. The second litter, if there is one, consists of only one or two piglets. Its courtship is a rough one. The male faces the female, nose to nose, and circles round her all the while snuffling as though to hold her in a trance. The moment he stops she seems to recollect herself and bites him or cuffs him with her paws. He then begins to circle her in the opposite direction. This may continue for hours after which the female may coolly walk off. A male may also be pushed off by another suitor. When the female consents, mating takes place and the young arrive after a period of 35 to 40 days. The number of young per litter varies from 2 to 9. The mother extends and lines her nursery with leaves. The young are born blind and naked. She brings them up all by herself and discourages any other hedgehog from coming near. For the first 24 hours she stays in the nest, suckling her young, after which she leaves periodically in search of food. The babies which soon grow spines are capable of rolling up into a ball at 11 days, not before that. From the eleventh till the fourteenth day, the eyes open slowly, first one, then the other. If the nest is disturbed, the mother carries the young by the scruff of the neck to a new shelter till it is safe to bring them back. They are weaned by 4 to 6 weeks. The young leave the nest after weaning and make new ones for themselves. They begin making short trips by the time they are a month old. Any reluctant hanger-on is driven out by the mother.

Unfortunately, the baby hedgehog does not know what play is. Perhaps that is why all work and no play makes the hedgehog a dull—hedgehog ! It sets out into the world armed with its prickly coat and the immunity it derives from its mother's milk. Foxes and badgers are its number one enemies and they usually get the better of it. Rats, its other enemy, have an even edge. Man, of course, with his automobiles, is the latest threat in the hedgehog world. In the wild it lives up to six years of age. In captivity it lives up to ten, and one rare specimen is said to have lived to the ripe old age of 14. It is generally a solitary animal except during mating.

Its senses of smell and hearing are its assets. It is said that a hedgehog can smell a stranger in another room. When it does so its nose begins to drip. It looks for its prey sniffing through the leaves and undergrowth. Each hedgehog works out its own paths, but often following the path of another it lands up far away from home. Its hearing, though acute, cannot help it to locate the direction of a sound. Voice signals play an important role in its communication. Squeaking by the young shows hunger. Hissing sounds exhibit fear and screams denote distress. While looking for food it grunts. Its vision is said to be generally poor but it has been proved that the hedgehog is sensitive to certain colours. It rarely detours to overcome an obstacle; it just passes over. However, it is a good climber and swimmer.

An eye for cosmetics

Another of its peculiarities is self-anointing. When stimulated by an odorous substance like leather, wood, talcum or even cosmetics and creams (and strangely distilled water too — though it is odourless to the human nose), the hedgehog licks on till frothy saliva is formed in its mouth. This is then placed on the spines by lifting the forelegs. All the spines are thus covered with the saliva. This is not such a hard task because the hedgehog's skin is loose and can be drawn forward. (The hedgehog can also change its shape from entirely spherical to oval to flat to pass through different openings.) The purpose of self-anointing is not certain, though several reasons are attributed to it. Of them, counteracting the body fleas, keeping the spines supple, identification and enemy repellants are oft-quoted reasons.

The hedgehog in India is found in the deserts of Rajasthan and in dry areas of the South. The genus Hemiachinus has large ears, probably to regulate heat. They can go without food or water up to 10 weeks. Another kind belonging to the genus Paraechinus can go without food and water for 4 to 6 weeks. This genus does not seem to take any vegetarian food. The European genus Erinaceus hibernates in the colder part of its range. The Indian hedgehog spends a passive winter and it digs its own burrow in the sand.

The hedgehogs' world is a strange one. This ancient creature seems to have survived merely by virtue of its prickly coat of armour. It is not very intelligent and often has a hard time facing the new dangers to which it has not adapted itself. A clever animal would run to escape the crushing death from under the wheels of a motor car. But the hedgehog merely rolls itself into a ball, thinking the vehicle will get scared. But alas it pays dearly with its life.

S. K. S.

Powders and Creams

SUMATI K. SAMPEMANE

MOST people think the skin is merely a sack for containing the various muscles and bones of the body. It is not just that. It also serves the purpose of protecting the body against the vagaries of the weather and the surroundings. It does this by acting as a heat exchanger and as a barrier against harmful external agents. Its natural fat secretions, the sebum, protect and lubricate it. But with the steep rise in airborne pollutants in our modern technological age, the sebum often attracts these pollutants and, as a result, inflicts harmful germs on the skin.

This is where soaps and detergents come in. The skin needs to be cleaned periodically and soaps serve the purpose. But there is one drawback to soaps: however gentle a soap may be, its constant use leads to the drying of the skin as the sebum is removed faster than it can be replaced. Besides, dry climates could dry the skin too. The only remedy to this loss of sebum is to supplement the skin with external fats.

This is not a new idea. Centuries back, people had rubbed fats into the skin to keep it from chapping. They wrongly believed that fats softened the skin. It is not true. Experiments have shown that pieces of dry skin immersed in oil for a considerable period of time remained as tough as before the immersion. Fats do not soften the skin but they do help in retaining water by checking its loss.

The upper layer of the skin, the epidermis, consists of four layers, the uppermost one being generated from the lower layers. As the cells travel to the surface they become flat, dry and horny. Even this layer is not absolutely dry. The epidermis gets its water from the steady stream which diffuses upwards through the blood vessels of the lower layer of the skin — the dermis. A minimum of 10 per cent moisture in the horny layer is essential to keep the skin from cracking.

The dermis contains oil and sweat glands and caters to the needs of the epidermis. Medical science has stretched man's life span but has not done much to retain the youth of the skin. Though the reason for ageing is not clearly known, it has been attributed to hormonal changes. On ageing the skin loses its elasticity and water-binding substance. It thus sags. And it is to keep the skin soft and radiant that the cosmetics industry came into being.

Not all cosmetics are a must. The basically essential ones are the creams and, to a certain extent, powders. Snows, vanishing creams, foundation creams, facial creams, whitening creams, night creams, nourishing creams, cold creams and cleansing creams are a few of the cream preparations used for specific purposes. Though creams come under many names and serve many purposes, they can be broadly classified as cold creams and vanishing creams. The former are oilbased. They consist of water dispersed in a fatty medium and are used to clean the skin and to keep it soft and pliable. The vanishing creams, being soap-based, are non-greasy and leave a thin protective film when their water content has evaporated. This protective layer of stearic acid acts as a suitable make-up base. Snow is just another name for vanishing cream.

Creams are emulsions of one substance dispersed in another. In cold creams, water is dispersed in the continous fatty phase and in vanishing creams water is the continuous phase and the fatty stearic acid is the dispersed phase. Beeswax, spermaceti (a fat obtained from the sperm whale), whitewax and almond oil are the chief fats used in the manufacture of cold creams. These, however, may be replaced by other fats, like paraffin and petrolatum.

The mixture of beeswax (the one most commonly used here) and oils is heated in a steam jacketed kettle from 68°C to 72°C to form a clear solution. Another solution of borax is heated in a separate kettle to a slightly higher temperature. The hot borax solution is then added slowly and with constant stirring to the heated fat mixture to form an emulsion. Perfume is added at 45°C to 50°C. The stirring of the mixture continues till it cools to room temperature. It is in the stirrer that the perfume (and colour in the case of facial creams) is added and the whole mass is transferred to a homogeniser where the particle size is reduced. The cream may be filled directly into bottles immediately after the perfuming and homogenising or may be cooled before filling. When hot-filled, there is a considerable shrinkage and it has to be topped off again with more cream.

Vanishing creams are similarly made. The stearic acid is heated in one kettle to 85°C while the mixture of alkali (NaOH) and glycerine is heated in another to 88°C. The two are then mixed and stirred till the solution comes down to room temperature. Perfume is added after 24 hours after which the

cream is bottled. The pearly finish of the vanishing cream comes from the stearic acid, which is always in excess of the alkali.

Cleansing creams

Cleansing creams are cold creams made of low melting oils that melt on contact with the skin. They get into the crevices and cracks and dissolve out the grime and dirt. The liquefied version of these cold creams—the cleansing lotions—are obtained by emulsifying light oils in water. They do the work of soap more gently and do not leave the skin alkaline or brittle. They are made especially to dissolve the fats holding the pigments used in make-up. Since the normal condition of the skin is acidic, acidic cleansing creams have been made off and on but without much success.

Though cleansing creams are gentle in action, they too remove the sebum. But there is one type, the Lanolin-enriched creams which are made to overcome the loss of body oils. Lanolin is a fat derived from wool and is the nearest to natural oils. Other adaptations of cold creams include night creams, lubricating creams, and conditioning creams.

Baby creams are also cold creams. But they are made with greater care and precision and tested dermatically as the intended users have extremely delicate skin. They contain very little water. Water causes cooling on evaporation which may be an undesirable effect for infants.

While cold creams cleanse and protect, vanishing creams remove any excess of sebum and form a thin protective layer. In addition they also give the skin a smooth, velvety look. Fats of very high melting point are used in the production of handcreams which are a type of vanishing cream. They contain barrier agents like silicone and soothing agents to overcome the ravages of detergents which defat and dry the skin. The high melting point gives the cream a non-greasy feel.

Among the other creams belonging to the vanishing cream type are some of the whitening creams. They normally contain mercury salts which, in addition to removing pigments, inhibit their formation. They are also antiseptic and have a softening effect on the skin.

Some creams have the properties of both vanishing and cold creams. They contain less fat than a normal cold cream and have instead a stearate component. These are the all-purpose creams.

Hormone creams are said to be beneficial in rejuvenating the ageing skin but have little effect on the young skin. Unfortunately, they have been suspiciously looked upon as cancer-forming agents. Compounds from which hormones can be synthesised are used in some creams in India but these are not the same as hormone creams.

Manufacturers make many controversial claims about their products. One such controversy centres round the so called nourishing creams. Some experts deny the efficiency of such a cream, stating that the skin, like any other organ, gets its nourishment from within. Being a barrier organ, it does not permit the entry of a compound from outside. Experimentally, none of the C_{14} labelled fats applied to the skin could be traced within the body even after 48 hours of application.

Yet others are of the opinion that topical applications are useful because the skin is permeable to fat-soluble vitamins and certain hormones. Experiments have shown that salts of heavy metals, salicylic acid and heavy water penetrate the rat skin and radioactive hydrogen water gets through the human skin too. But then heavy water and radioactive hydrogen water are not the same as pure aqua and are not used in cream preparations.

Powders

In the cosmetics range, creams are the primary necessities of the skin. But powders cannot be dismissed merely as decorative beauty aids. A body powder helps to overcome a lot of discomfort and also hides blemishes. By absorbing the sweat it increases the surface area of evaporation and lubricates the folds of the skin, thus preventing nappy rash in babies. The excessive oiliness of the skin is also reduced for the powder is absorbent too.

The most important ingredient of powder is talc, also known as soapstone. It is mined in Rajasthan. A soft mineral, it adheres to the skin in the powdered form. Talc used for powders is selected photo-electrically, and the particle size of the ground talc is checked microscopically. Its flat, lamellar structure gives it the slip and translucent appearance.

To increase the covering power of a powder, zinc oxide or titanium dioxide is added. Zinc or manganese stearates increase the spreading power and improve the adherence. Kaolin, calcium carbonate and boric acid are other optional ingredients. Magnesium carbonate is used as the perfume carrier. Care is taken to see that all iron salts (even trace iron impurities) are eliminated for they cut down the perfume retention.

All the ingredients of the powder, except magnesium carbonate, are mixed and powdered in a

(Contd. on page 63)

MAGNETISER

IT usually happens with screw drivers and small drill bits. They very often get magnetised in use and their acquired magnetism proves irritating at times. Or at the other extreme, one of your projects requires a magnet of special dimensions. And this magnet is not available in the market. Again you feel irritated when you have to abandon your entire project.

It is possible, however, to overcome these minor irritations. All you need is an inexpensive magnetiser/demagnetiser. Or better still, you can build one at home. Once you do build it you can turn out dozens of magnets in various shapes and sizes. And at the push of a button you can very easily demagnetise any magnetised item from screw drivers to wrist watches. You just pass the magnetised item through the coil and press the button.

Similarly to make a magnet, the bit of material is passed through the magnetiser coil (Fig. 1) and the button (P_1) is pressed. The strength of the magnet can be varied by adjusting the rheostat. When P_1 is pressed, a current flows through the coil L and creates a strong magnetic field that magnetises the material. But not all materials can be magnetised. Iron loses its acquired magnetism in a short time. Steel (hardened), however, can be magnetised strongly and it also retains its magnetism indefinitely. But the best magnets are made from certain alloys. One such, the most popular in fact, is Alnico, an alloy of iron, nickel, cobalt and aluminium. But it is a material not easily available to the amateur electrician. A new ceramic, ferrite, which is used as an antenna in radios can prove a good substitute. Though it is not as strong a magnet as steel, it retains its magnetism despite all conventional methods to demagnetise it.

The magnetiser is the coil L which is connected to the mains via a rectifier D and a rheostat R_1. The rectifier changes the AC current to a DC current. A DC current is necessary as only a unidirectional field will magnetise. The rheostat, as mentioned earlier, adjusts the magnetic strength.

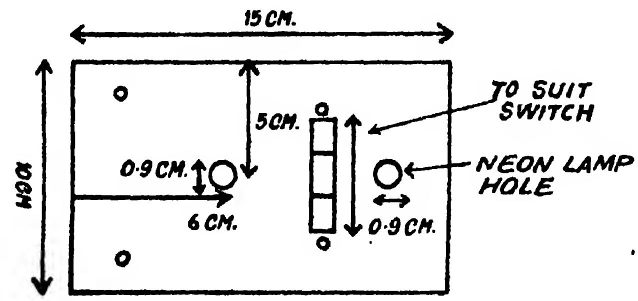
The controls comprise a three-button switch (piano type). They are the 'off' to switch off the unit, the magnetiser switch and the demagnetiser switch.

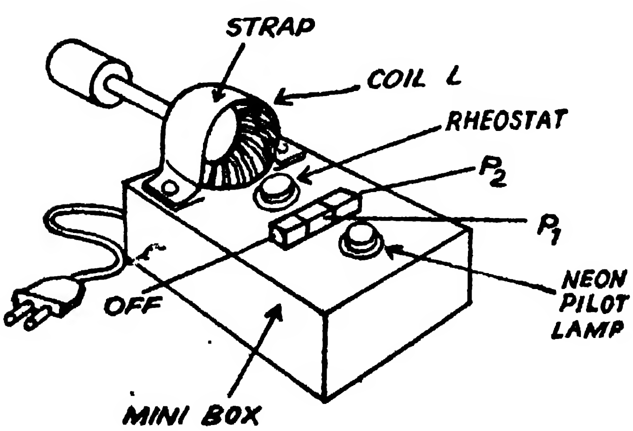
The principle of operation is simple. When the push button P_1 is pressed the power supply turns on. The AC is rectified to a pulsating half-wave DC current by the silicon diode D. This current is fed across the resistor that limits the current to a safe value. This voltage is applied across the capacitors C_1 and C_2 which smooth out the AC component of

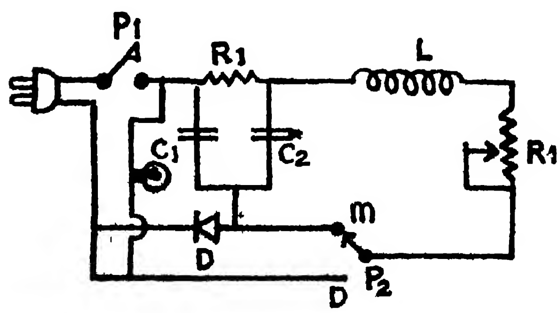
Fig. 1, bottom left: Magnetiser

Fig. 2, top right: The layout for holes

Fig. 3, bottom right: The magnetiser circuit







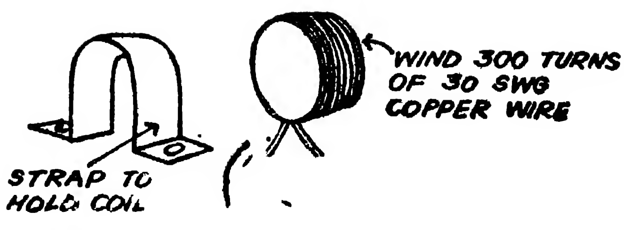


Fig. 4: The coil

the DC current. The reasonably stable current is then passed to the coil through the rheostat.

When the push button P_2 is pressed, the coil is connected to the mains through the resistors R_1 and R_1. The capacitors, C_1 and C_2, and the diode are thus ' shorted ' out of the circuit.

The magnetiser consists of an aluminium mini-box which houses the switch, the rheostat and the diode. The 10 cm × 15 cm × 7·5 cm mini-box is drilled as in Fig. 2. The switches and rheostat are screwed in place and soldered as in Fig. 3. The resistors and capacitors are soldered on to the switch itself.

The coil (Fig. 4) consists of a 4 cm diameter plastic/fibre/paper tube around which is wound 300 turns of 30 swg enamelled copper wire. This winding is covered with a tape of cloth that passes through the tube so that the wires cannot be touched from the outside. The coil is fixed on the mini-box by means

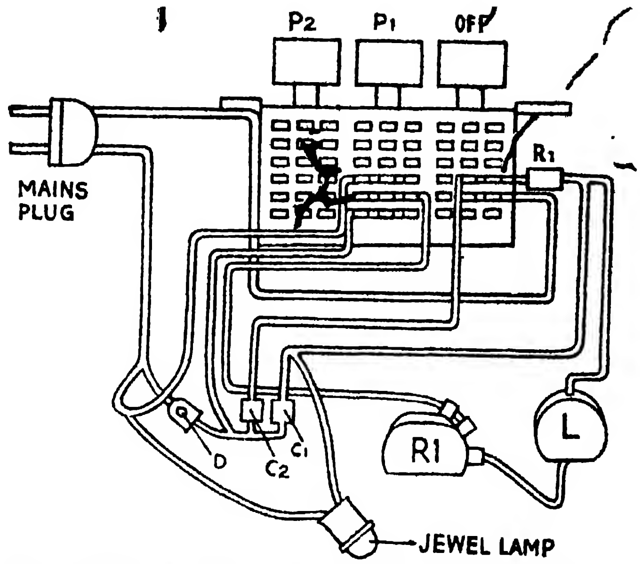


Fig. 5: Schematic diagram of the complete unit

of an aluminium strap. The neon jewel lamp is an indicator to show that the magnetiser is on.

You will need:

Switch S: 3 push button, band switch; *Rectifier:* BY127; *Resistors:* R_1 — 100 ohm, 20 watt, R_2 — 100 ohm, 20 watt, potentiometer; *Coil* L: as per text; *Capacitors:* C_1 — 25 mfd 300 V electrolytic, C_2 — 25 mfd 300 V electrolytic; *Misc:* 230 V neon jewel lamp.

F. Rehman

HOVERTRAIN

As pressure on urban transport is increasing all over the world, several countries are working on new, faster methods of transport. The Germans have been working on two new road transport systems. One is to run small, two-seater computerised plastic cabins automatically on a fixed track where a passenger chooses his destination and then drops a punched or magnetic card into a slot in the cabin. Being small, they can run on the sides or the middle of two-way roads, in underground tunnels or aerially on support poles. The second is a container-carrier system, where the passenger is slid into and out of a bus or train in a small cabin.

For sometime now, some countries have been working on a hovertrain which can move above the rails. One version of this will use a thin layer of air to lift the train off the rails. Another is to lift the train off the track using magnetic repulsion; this would require superconductors to produce such a strong magnetic field. The Stanford Research Institute in California, USA, is working on this magnetic levitation system.

The first hovertrain system running on an air cushion and guided tracks will soon be introduced in Paris to ease the traffic congestion in its crowded suburbs. The line will extend 25 km from Cergy to Defence in Paris. A linear motor, another recent development, will be used to drive the train. In trial runs recently, the train reached a speed of 180 km. The line will cost about Rs. 38 million a mile as it passes through crowded areas. But it will eliminate much of the noise and pollution involved in conventional systems.

Meanwhile, Britain is also experimenting with the hovertrain and has completed the air cushion system. Initial trial runs reached 10 km an hour which is to be raised eventually to 100 km. When the technology is perfected, the hovertrain may offer an alternative to many cities for short-run city transport or long-route suburban transport.

TWA's NEW AMBASSADOR SERVICE. SAME PRICE AS OTHER AIRLINES' ECONOMY SERVICE.

We must admit that other airlines could offer you something like TWA's new Ambassador Service.

All we did was see what our competitors were giving in terms of comfort, meals, entertainment and ground services.

Then worked all year to give you something better.

Sometimes this cost a fortune (we ripped out the insides of all our 707's and renewed everything from the floor up).

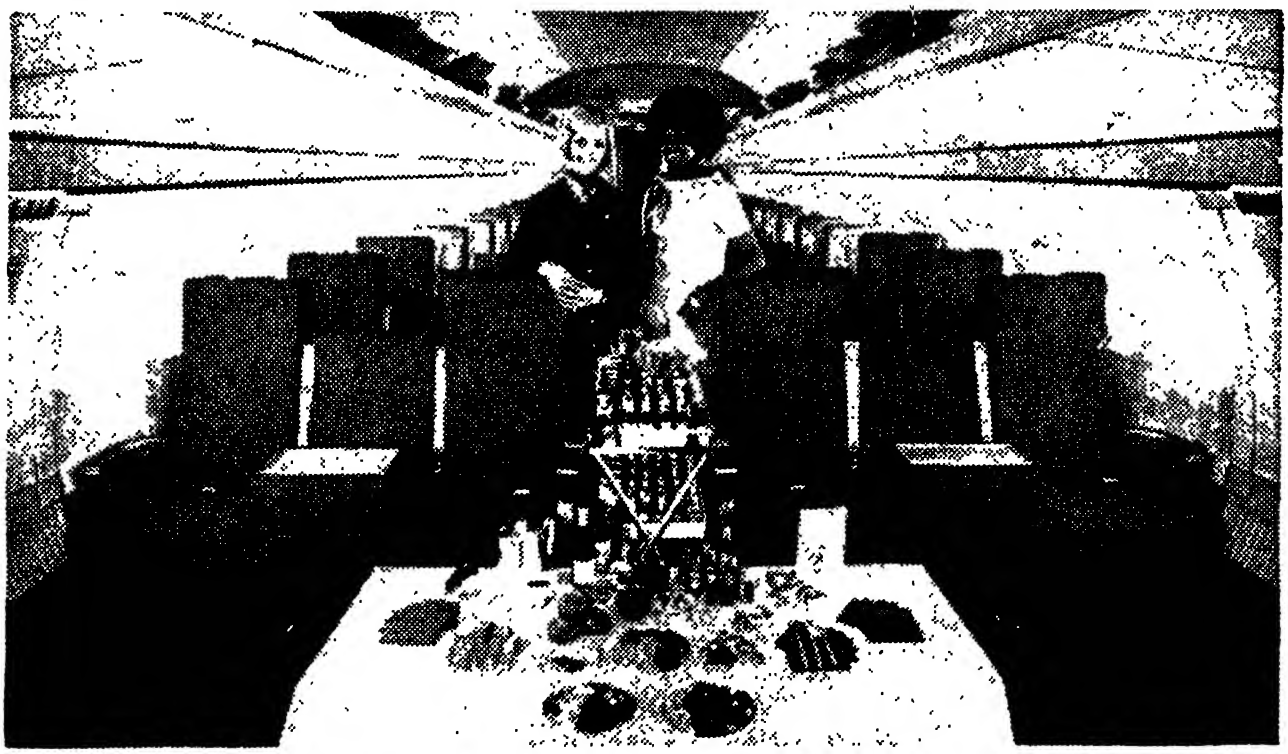
Sometimes this cost a little more trouble (offering a choice of three meals in economy rather than no choice).

And sometimes it cost nothing but a little thought (no-smoking sections, for example).

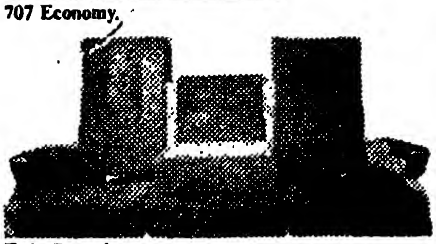
Next time you fly to America, ask your travel agent to book you a TWA Ambassador flight.

If it isn't considerably better than the service other airlines offer you, fly back with one of them.

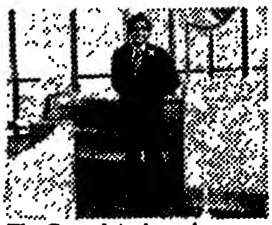
They all charge the same as TWA's new Ambassador Service.



707 Economy.



Twin Seats in economy.
Only TWA gives you this twin seat on 707's in economy. It can be three across, or if the plane's not full, two across or even a couch.



The Ground Ambassador.
Whatever your problems, he'll help you from booking a car to getting a hotel to phoning your office.

New uniforms for hostesses.
We've given our girls a choice of three uniforms (including hot pants) designed by Valentino. It helps.

Choice of three to five meals.
Only TWA offers you a choice of three meals in economy, five in first class.

No smoking sections.
Many Ambassador features cost a fortune. This one just cost a little thought.

TWA's new terminal in New York.
For TWA passengers only. You can be through it, having cleared customs and immigration, inside twenty minutes. Most airlines still share one old terminal.

Choice of films.
TWA offers you a choice of films (one for adults, one for everybody).* Most airlines still show one, or none.

TWA

THE WORLD'S LARGEST AIRLINE SERVING ASIA.

Offices in Bombay • Calcutta • Delhi
Madras • Ahmedabad • Kathmandu

QUESTION & ANSWER

What is the smallest possible unit of time?

SHORTLY after 1800, it was suggested that matter came in certain small units called "atoms". Shortly after 1900, it was accepted that energy came in certain small units called "quanta". Well, then, is there any other commonly measured quantity that comes in small fixed units? Does time, for instance?

There are two ways of finding a "smallest possible unit". There is the direct way of dividing some measured quantity until it can be divided no more — to break down measured masses into smaller and smaller quantities till you have a single atom, or to break down measured energies till you have a single quantum. The other is the indirect way of noting some phenomenon that can't be explained unless you assume the existence of a smaller possible unit.

In the case of matter, a wide variety of chemical observations, including the "law of definite proportions" and the "law of multiple proportions," made an atomic theory necessary. In the case of energy, a consideration of the radiation of a black body and of the existence of a photoelectric effect, made a quantum theory necessary.

In the case of time, the indirect method fails — at least so far. There are no observed phenomena that make it necessary to suppose that there is a smallest possible unit of time.

What about the direct method? Can we observe shorter and shorter periods of time until we come to something that is ultimately short?

Physicists began to deal with ultra-short time intervals after the discovery of radioactivity. Some types of atoms had a very short half-life. Polonium-212, for instance, has a half-life of less than a millionth (10^{-6}) of a second. It decayed in the time it took the Earth to travel one inch in its 18½-mile-per-second journey about the Sun. Yet, though physicists studied these processes in detail, there was no sign, during that interval, of a time-flow in little bits rather than continuously.

But we can go farther. Some sub-atomic particles break down in far shorter intervals of time. In a bubble chamber, certain particles, travelling at nearly the speed of light, manage to form tracks three centimetres long after forming and before breaking down. This corresponds to a lifetime of a ten-billionth (10^{-10}) of a second.

Even that is not the best we can do. In the 1960s, particularly short-lived particles were discovered. They existed so briefly that, even travelling at nearly the speed of light, they could not move far enough to leave a measurable track. The length of time they existed had to be calculated by indirect methods and it turned out that these ultra-short-lived "resonance particles" existed for only ten-trillionths of a trillionth (10^{-23}) of a second.

Such a short time is impossible to grasp. A resonance particle's lifetime is to a millionth of a second as a millionth of a second is to 3,000 years.

Or look at it another way. Light travels in a vacuum at 300,000 kilometres a second and this is the fastest known velocity. How far can light travel while a resonance particle comes into being and goes out of being? The answer is 10^{-13} centimetres or just about the width of a proton!

Yet there is no reason to think the lifetime of a resonance particle must be the smallest bit of time there can be. There is still no sign of a limit.

Isaac Asimov

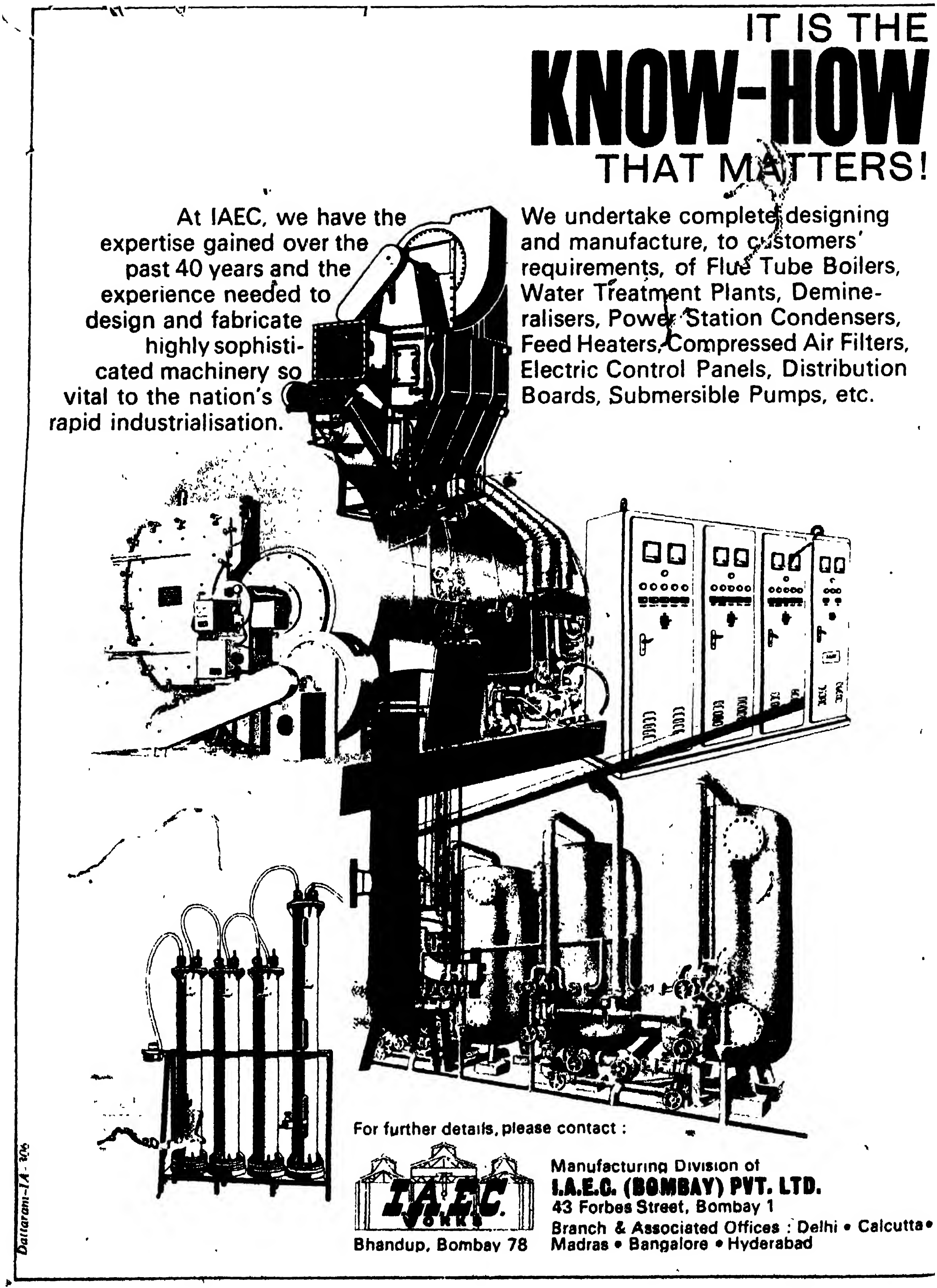
Things we use . . . *(Contd. from page 59)*

pulveriser. The magnesium carbonate is pulverised separately and the (alcoholic) solution of perfume sprayed on it. The two mixtures are put together, mixed and sieved. The final particle size of the powder is 63 microns. The ready powder is conveyed to a vacuum filler from which it is filled into tins and sealed.

The powdering of the ingredients is done by subjecting them to high pressure (7 kg per sq cm) in a continuous, purified stream of cold air which revolves in a drum-shaped chamber. The air revolves inside the chamber at a speed higher than 1600 kmph and in this cyclone the particles are micronised. When the process is completed the fluffy, light pulverised powder leaves through a central exit and the heavier particles settle down.

The difference between face and body powders is only in the colour. Face powders contain certain pigments (or dyes or lakes). Baby powders do not contain any boric acid.

Face powder, when mixed with a suitable binder and pressed into a metal plate under controlled pressure, forms a dense compact mass — the compact powder. Powder is also the base material for cake make-up. When mixed with oil or wax, it forms a water-repelling make-up. Liquid powders had their day when powder was emulsified in water or oil which dried on application, leaving a smooth, long-staying film. Their extreme drying effect made them unpopular and they went out of use.

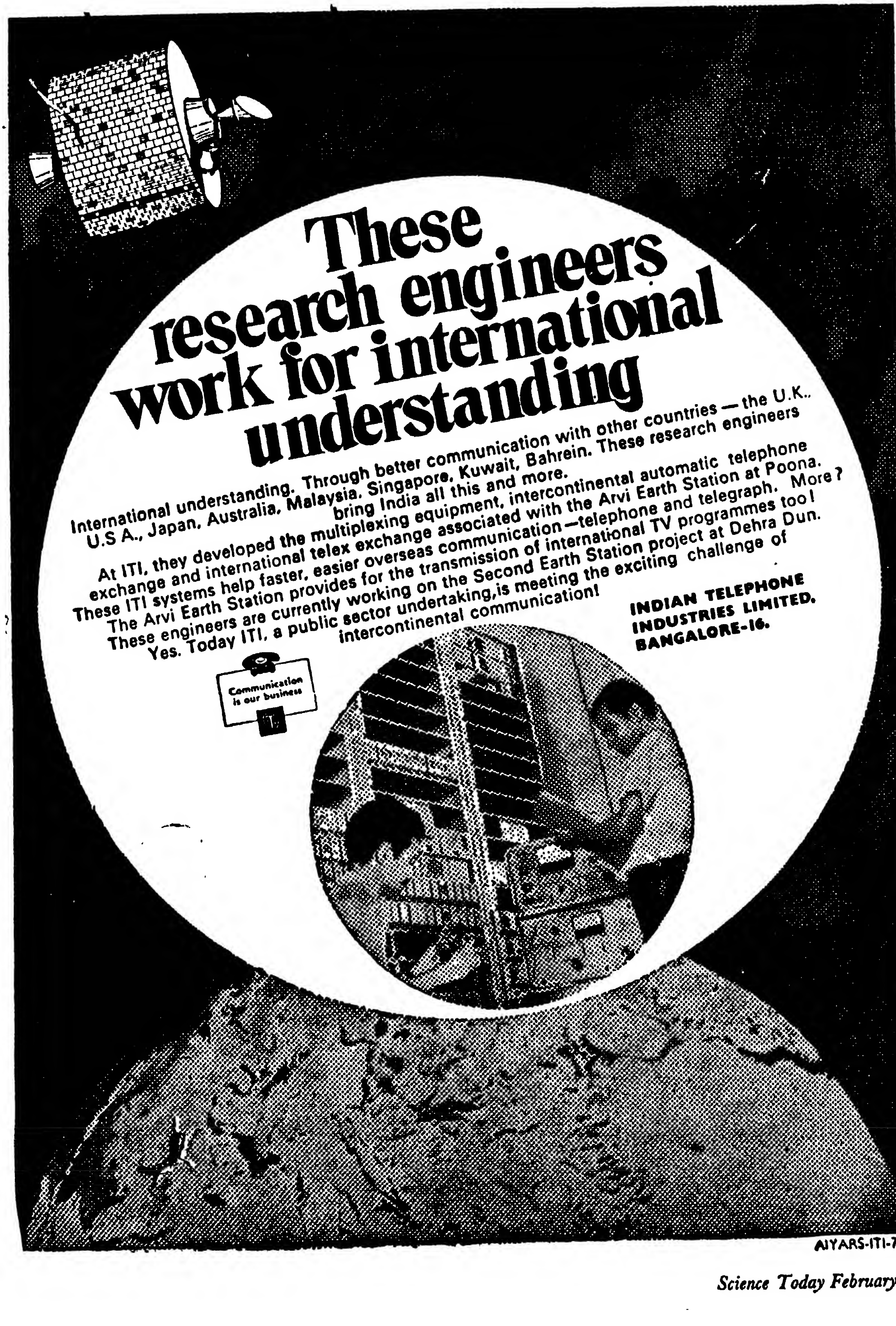

IT IS THE
KNOW-HOW
THAT MATTERS!
At IAEC, we have the expertise gained over the past 40 years and the experience needed to design and fabricate highly sophisticated machinery so vital to the nation's rapid industrialisation.
We undertake complete designing and manufacture, to customers' requirements, of Flue Tube Boilers, Water Treatment Plants, Demineralisers, Power Station Condensers, Feed Heaters, Compressed Air Filters, Electric Control Panels, Distribution Boards, Submersible Pumps, etc.
For further details, please contact :
I.A.E.C.
Bhandup, Bombay 78
Manufacturing Division of
I.A.E.C. (BOMBAY) PVT. LTD.
43 Forbes Street, Bombay 1
Branch & Associated Offices : Delhi • Calcutta • Madras • Bangalore • Hyderabad

A TIMES OF INDIA PUBLICATION FEBRUARY 1972

SCIENCE TODAY

FOR EVERYMAN


AnalaR
Barium hydroxide


These research engineers work for international understanding
International understanding. Through better communication with other countries — the U.K., U.S.A., Japan, Australia, Malaysia, Singapore, Kuwait, Bahrein. These research engineers bring India all this and more.
At ITI, they developed the multiplexing equipment, intercontinental automatic telephone exchange and international telex exchange associated with the Arvi Earth Station at Poona. These ITI systems help faster, easier overseas communication—telephone and telegraph. More? The Arvi Earth Station provides for the transmission of international TV programmes too! These engineers are currently working on the Second Earth Station project at Dehra Dun. Yes. Today ITI, a public sector undertaking, is meeting the exciting challenge of intercontinental communication!
Communication is our business
INDIAN TELEPHONE INDUSTRIES LIMITED. BANGALORE-16.
AIYARS-ITI-718

Vol. 6 No. 8 February 1972

SCIENCE TODAY

COVER

" Farewell to Arms " may be a fairyland graffiti. But consider the alternative! (*Painting by Shabbir Diwan*)

Annual Subscription Rs. 12·50
Single copy: Rs. 1·25; 10p

Editor Printed and published for the proprietors Bennett, Coleman & Co., Ltd., by Pyarelal Sah at the

AWARDS & APPOINTMENTS

Sarabhai's successors

MENON

SETHNA

IT took four months to appoint the chief of the Atomic Energy Commission after Dr. Bhabha died. It has taken less than a month to choose Dr. Sarabhai's successors. **Mr. H. N. Sethna** takes over as the Chairman of the AEC and Secretary, Department of Atomic Energy. He retains his earlier job as Director of the Bhabha Atomic Research Centre.

Prof. M. G. K. Menon becomes the new Chairman of the Indian Space Research Organisation and Director of the Physical Research Laboratory, Ahmedabad. He is already the Director of the Tata Institute of Fundamental Research, Chairman of the Electronics Commission and Secretary, Department of Electronics, Government of India.

A chemical engineer by profession, Homi Nusserwanji Sethna has been looking after the affairs of the BARC since 1966. His greatest achievement is the construction of India's first, and the world's fifth, plutonium plant commissioned in 1964. "It sounds incredible," he had said with a boyish grin after the plant was completed, "but you know I had never seen plutonium before, nor had any of my colleagues." His other achievements have been the commissioning of the Rare Earth's Factory Project in 1952, the thorium (1955) and uranium (1958) metal projects and the thorium mill at Jaduguda. He was also the project manager of the Canada-India Reactor which went critical in 1960.

Mambillikalathil Govind Kumar Menon is a product of Bristol — the hectic late-forties when the late Nobel Laureate Cecil Powell was leading the 'Bristol Group' towards important breakthroughs in the nuclear emulsion technique for the study of cosmic rays. His achievements in the six years he spent with Powell, include the first clear observations of cosmic ray high-energy neutrino interactions and proving the existence of muons of varying energies, mono-energetic high-energy pions and electrons amongst the decay products of heavy mesons.

He has been with the TIFR since 1955 — first as Reader, then Associate Professor (1958), a full Professor and Dean of the Physics Faculty (1960), Senior Professor and Deputy Director (Physics) (1964) and finally Director in 1966 after Bhabha's death. In 1970 he was elected a Fellow of the Royal Society of London. He is 43.

The separation of the space and atomic energy commands is a welcome step. Space research in India has already acquired a stature of its own. The separation, however, may not be more than tenuous. The TIFR and the PRL are administratively attached to the Department of Atomic Energy — for purposes of receiving grants-in-aid from the Central Government. The PRL again happens to be the nucleus of all our space activities. The BARC too has blood ties with the TIFR — many of its scientists belonged to the TIFR originally. The mantle of Sarabhai may not have been split after all.

New ICAR Chief

Dr. M. S. Swaminathan, head of the Indian Agricultural Research Institute at New Delhi has been appointed Director-General of the Indian Council of Agricultural Research. Winner of last year's Magsaysay Award, Dr. Swaminathan has been called the man most responsible for making the "green revolution" an Indian reality. Last December, he had proposed a crash programme for increasing both food and cash crop production to offset possible losses in border areas as well as from stoppage of foreign aid.

His new appointment gives him the rank of Secretary to the Government of India, at par with the Chairmen of the Atomic Energy and Electronics Commissions.

Mr. P. Kumaraswamy, Director of the Irrigation Research Station at Poondi, Tamil Nadu, has been elected Fellow of the Indian Academy of Sciences.

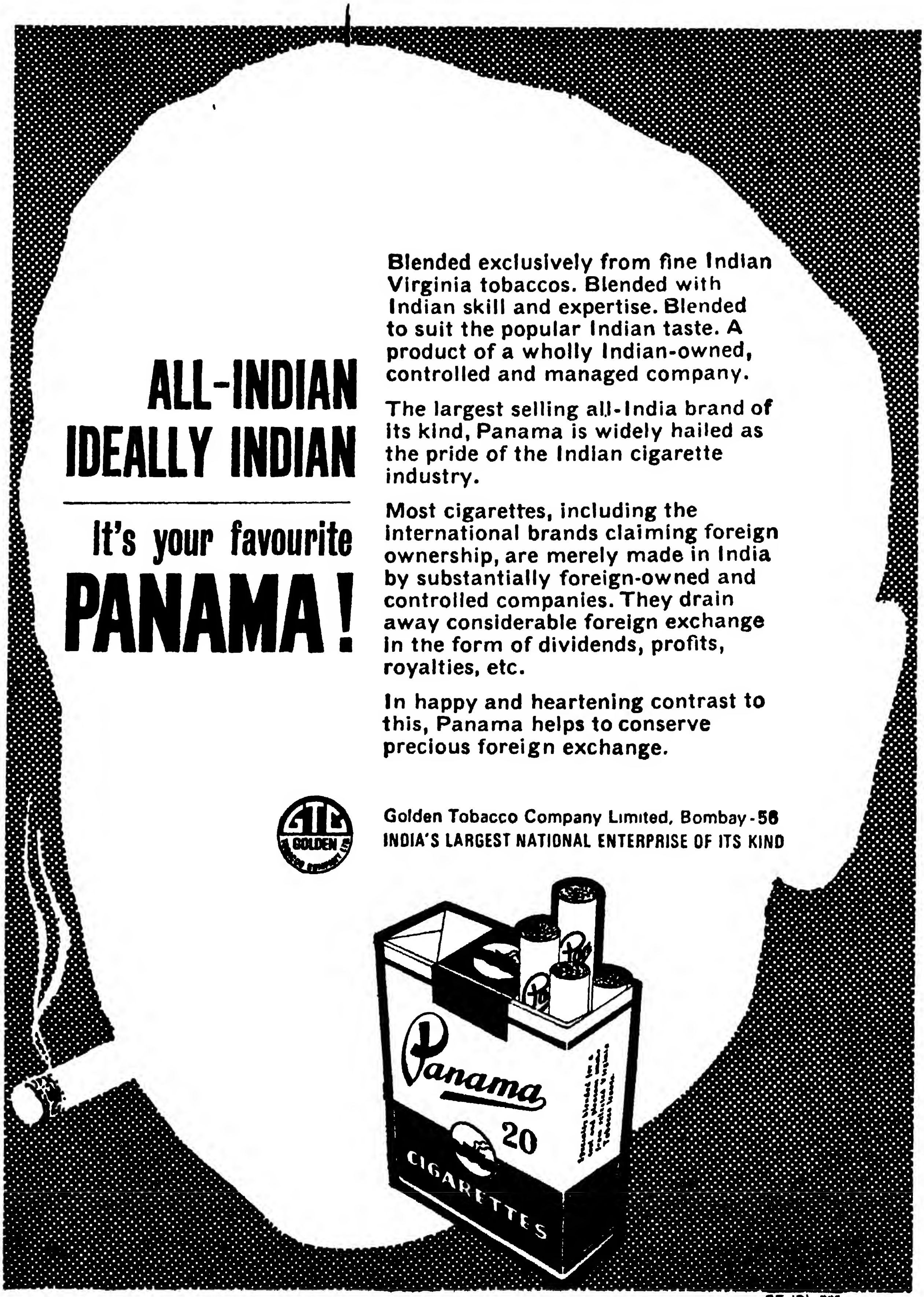
IN THE FORTHCOMING ISSUES

WEALTH FROM THE OCEANS

SUPERCONDUCTIVITY

GENETIC ENGINEERING

METALLURGY IN ANCIENT INDIA


ALL-INDIAN
IDEALLY INDIAN
It's your favourite
PANAMA!
Blended exclusively from fine Indian Virginia tobaccos. Blended with Indian skill and expertise. Blended to suit the popular Indian taste. A product of a wholly Indian-owned, controlled and managed company.
The largest selling all-India brand of its kind, Panama is widely hailed as the pride of the Indian cigarette industry.
Most cigarettes, including the international brands claiming foreign ownership, are merely made in India by substantially foreign-owned and controlled companies. They drain away considerable foreign exchange in the form of dividends, profits, royalties, etc.
In happy and heartening contrast to this, Panama helps to conserve precious foreign exchange.
GTC
GOLDEN
Golden Tobacco Company Limited, Bombay-58
INDIA'S LARGEST NATIONAL ENTERPRISE OF ITS KIND
Panama
20
CIGARETTES

SCIENCE SHAPES LIFE

TOWARDS MORE DOCTORS

In the last 10 years, 236 new medical schools were created all over the world. The total number now stands at 918, according to the World Health Organisation.

Up to the end of World War I, there were about 400 medical schools — Europe accounted for 160 of them and the US for 75. In 40 years, 284 more schools were added to the world total. And in the subsequent 10 years another 236 were created.

Brazil holds the record with 53 new medical schools in the past 10 years. India follows with 40 and the US with 21. Between 1920 and 1960, the USSR opened 59 schools and India opened 43.

Now, 104 countries in the world boast at least one medical school. Yet large areas of the world are still without any.

CANCER IN THE NEWSPAPER WORLD

The title doesn't suggest the attitude of newsmen to the dreaded disease, cancer. Rather it means that lung cancer may be an occupational disease for newspaper workers. So say two reports published in the *British Journal of Industrial Medicine* (20 January 1972).

Dr. M. Greenberg of the Department of Employment in Britain found lung cancer deaths to be more common than expected and deaths from bronchitis less common in a review of death certificates of London printing workers. In a larger study, a team from the Manchester University Occupational Health Department led by Professor T. S. Scott examined the causes of death of 3,845 workers in the newspaper industry in Manchester and London between 1952 and 1968.

The printing workers were the susceptible ones, not the white-collar reporters and sub-editors. Though the overall difference in deaths from lung cancer was about 30 or 40 per cent, twice as many deaths from lung cancer as expected occurred among machine-room men in Manchester.

People might argue that the investigation did not take into account the smoking habits of the men involved — after all smoking has been connected with lung cancer incidence. But Prof. Scott has this argument. If smoking was a factor to be considered then deaths from bronchitis too should have been of above average occurrence for smoking is as closely identified with bronchitis as it is with lung cancer.

This susceptibility to lung cancer is an occupational hazard of many other industries — for example in the nickel-smelting industry. In the machine room, the suspected cancer-causing agent might in all possibility be the oil spray which spreads in the air.

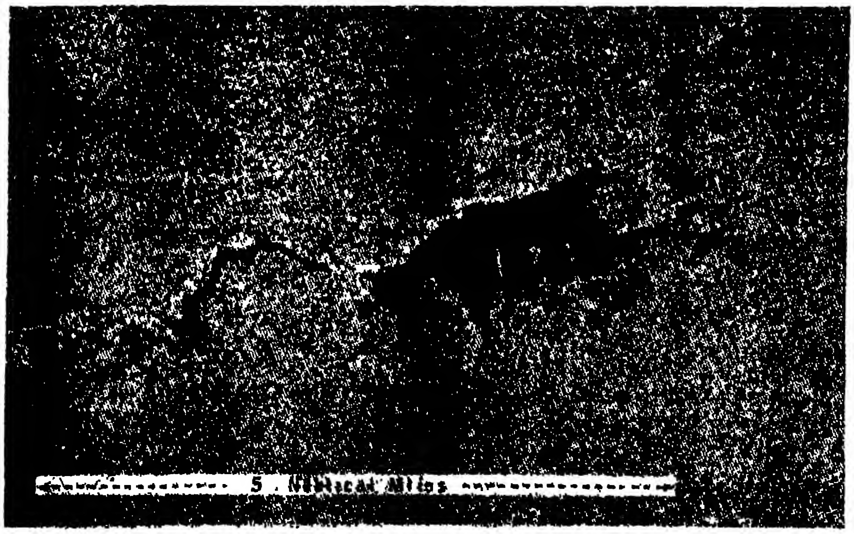
AVID READERS

Swedes remain the world's most avid newspaper readers with more than one daily in circulation for every two people in the country, according to the latest *Unesco Statistical Yearbook*. Japan leads in Asia with 503 copies of newspapers for every 1,000 people.

RADAR TO DETECT POLLUTION

This is another spin-off from space technology. Radar detection techniques, hitherto used in Earth Resources Survey from Satellites, are now being used to detect large oil-spills on the seas.

This new application was quite an ingenious discovery. It was found that because oil has a calming effect on water, this greatly reduces the energy returned from radar signals striking the water's surface at near-grazing angles. This makes mapping radar a useful tool for wide-area surveillance for oil spills. This radar image of 54,500 litres of oil was obtained with the US Navy's four-frequency synthetic aperture radar mounted on an aircraft flying at 600 metres.



ERGONOMICS AND THE MANUAL LABOURER

They do it for astronauts. And to a lesser extent for people like car drivers and office workers. But no one ever thinks of the manual labourer. Except maybe two Indian ergonomists, S. R. Datta and N. L. Ramanathan. (Ergonomics is the study of man in relation to his working environment.) It seems odd that so much effort goes into optimising the working environment of specialised people when the largest energy expenditure around the world goes in manual labour. Datta and Ramanathan studied the energy used and the cardio-respiratory stress involved in carrying loads in seven different ways. Their results (*Ergonomics*, *14*, 269) show that the best method is also the least used.

Their seven subjects carried 30 kg of granite chips over one kilometre at five kmph. The load-carrying modes included: *Double pack* — the load is divided into two packs and strapped across the shoulder, one in front and one at the back; *Head* — the load is carried in a basket on the head with a straw ring as padding; *Rucksack*;

Ricebag — the load is carried in a sack on the back with the upper corners of the sack held by the hands; *Sherpa* — like ricebag except that the sack is supported by a band around the forehead; *Yoke* — the load is suspended from the ends of a pole which sits on the shoulder; and *Hands*.

The ergonomists found that carrying loads with the hands involved the maximum energy expenditure and cardio-respiratory stress. The best method — with the least energy expenditure — was the double-pack. But strangely it is not widely used. In India, even when a load can be divided in two for double-pack transportation, labourers go in for the yoke method which involves a 30 per cent greater energy expenditure.

HOW TO GET AN INTELLIGENT BABY

No mother would like to give birth to a mentally retarded child. There is a possibility that she needn't if answers can be found to the questions raised by the researches of John W. Money of Johns Hopkins School of Medicine, Baltimore, USA. Reporting in *Impact of Science on Society* (December 1971), Money states that high levels of fœtal sex hormone may be a direct cause of increased intelligence. He studied the effects of excess androgen (male sex hormone) on fœtuses before birth.

This excess of androgen in a pregnant woman can stem from a malfunction of the adrenal cortex. It fails to synthesise cortisone and instead secretes a precursor hormone that acts like an androgen The result of this excess in the female fœtus is a change in the external genitalia to their masculine counterparts. The male fœtus does not experience such a change but the newborn infant loses a lot of salt. Both male and female infants, however, show premature signs of puberty. Cortisone therapy has helped rectify both salt loss and premature puberty. But this therapy has been used only since 1950. So a generation of children have grown up since then, unaffected by post-natal androgen excess. Money studied these individuals.

He found them to be more intelligent than the general population. In a population, 2·2 per cent have an IQ of 130 or higher. In the excess-androgen group the percentage is 12·9. Money tested 70 males and females. But the tests are not large enough and need to be confirmed by other tests on larger sampling groups.

Money also investigated a syndrome resulting from exposure of the fœtus to progestin (a synthetic form of progesterone, the female hormone that prepares the womb to receive the fertilised egg). Progestin, which used to be given to prevent miscarriages, causes the external genitalia of female fœtuses to become partially or fully masculinised. Money tested 10 females with such induced hermaphroditism. Six of them had IQs over 130 and none had an IQ below 100.

Other such investigations are going on in Holland, Israel

HOW THE JET-AGE BODY REACTS

The danger sign has been out for the jet set a long time now. But no one seemed to notice it. Till perhaps the recent inquest into the suicide of a World Bank executive. One of the contributory factors, said the coroner, was the "extraordinary number" of flights the man made before his death. His schedule was correlated to his death.

The advertisements might tell you otherwise. But jet travel is exhausting. For it upsets many things: your heart, your hormone balance, your circadian rhythms. And it makes you want to thump tables and cry hysterically and have irrational outbursts. The funniest part of the whole affair is that a medical formula has been worked out by aviation doctors to combat this jet travel syndrome. But, save for a few companies, no one uses it.

Dr. Lloyd Buley of the International Civil Aviation Organisation is the deviser of the formula. The formula takes into account not only the actual

and the USSR and it is only with an accumulation of data that any positive conclusions can be drawn. For example, how exactly does the excess hormone affect a fœtus? Money believes it works directly on the brain. If so, the reasons for mental deficiencies might be traced to the lack of sex hormones at a critical period. If this is proved then there is hope for mentally retarded children.

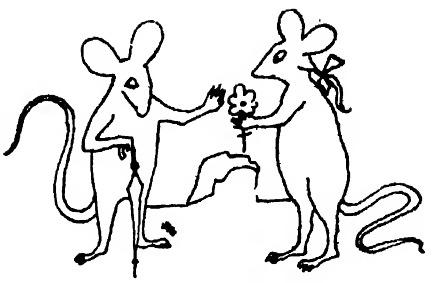
CAN HOMOSEXUALITY BE INDUCED? MAYBE!

Scientists may not yet approve the experiment on human beings, but there is more than one point to take note of. First, homosexuality may not be purely psychological. Second, if the mother goes through a stress during pregnancy, the offspring may be born a homosexual.

And last, that's what happened with rats at Villanova University in Pennsylvania (USA) during an experiment by Dr. Ingeborg Ward. Pregnant rats (third week) were subjected to regular periods of stress by being confined to a small, brightly-lit compartment. The male offspring born of these mothers displayed not only less sexuality but also female responses when approached by normal male rats.

Sexual differences keep developing just before or even immediately after birth, and any manipulation of the rats' hormonal balance at this stage would produce similar results. Which may explain Dr. Ward's findings, because it is known that stress affects the hormone output by adrenal glands.

Dr. Ward suggests stress -- any kind, including food shortage and

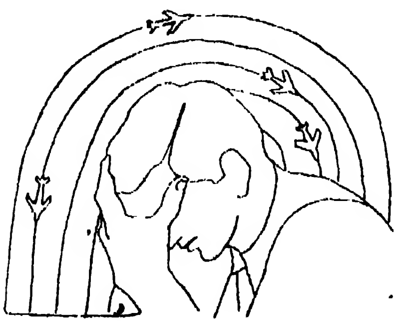


overcrowding — may be used to limit population in the animal world, as the reduced sexuality in the offspring will also affect the reproduction rate. Her study may also be of relevance for studies on homosexuality going on elsewhere. For instance, an Edinburgh, England, research team has discovered definite differences in the pattern of sex hormone excretion in the urines of homosexuals and heterosexuals.

---

flight duration but also the effect on our biological clocks of flying through the day and night. The complete equation is: Rest period (in tenths of a day) equals flight duration in hours divided by two, plus the time zones passed in excess of four, plus the departure time coefficient. The coefficients are based on social behaviour patterns, especially sleep periods.

The formula, when applied to a London–Los Angeles trip, involves a one and half days' rest period. A London–Sydney trip means two and a half days' rest. And, strangely, passengers flying west to east across the world's time zones require more rest than those flying east to west. For example, Montreal to



London means a day's rest whereas a London to Montreal trip needs no subsequent rest period. The vital factor is to make the combined departure and arrival coefficients as low as possible as the passenger has no control over the flight duration.

Dr. George Christie, medical director of Syntex Pharmaceuticals at Maidenhead, UK, goes even further. While agreeing with Dr. Buley he says it can take up to 10 days for the body's clock, as expressed in body temperature, hormone balance and other rhythms, to return to normal.

Hormone balance has been connected with mental functioning. It might take four to five days for the general mental performance to return to normal. Effects on sleep patterns are determined by the age of the traveller. The older he is the more the pattern is disturbed.

Both Drs. Buley and Christie feel the need for definite rules for rest periods for high-flying executives moving back and forth through time zones. Most companies leave it to the discretion of the executives themselves. But they little realise that executives may be asked to make a vital decision at a time when their vital decision-making processes are impaired by a long flight.

Much of the research on the "jet-lag" in the US has been done by the Federal Aviation Agency. One test was on passengers travelling from Oklahoma City to Rome (seven time zones) and Manila (10 time zones). All showed marked physical changes in body rhythms. In marked contrast were the insignificant effects on travellers flying from Washington to Santiago, Chile (one zone).

It does not stop there. Modern supersonic flights will bring further problems by increasing the time-zone disruptions.

All this forces one to pause and think of the many high-ranking officials who are forced to hop-step from conference to conference to meetings to laboratories, etc. This constant inter-time-zone flying would, as the formula shows, affect both their health and performance. It all adds up to the fact that man is perhaps going too fast for his own good.

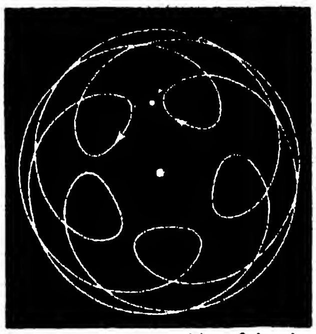
a comprehensive range of heavy electrical equipment
WE MANUFACTURE FOR YOU
• Water Turbines and Generators
• Synchronous Condensers
• Steam Turbines and Generators complete with Condensers and Feed Heating Equipment
• Power Transformers and Instrument Transformers
• High Voltage Switchgear
• Electric and Diesel Electric Traction Equipment
• Industrial Motors and Controlgear
• Silicon Rectifiers and Capacitors
ALL EQUIPMENT TO BRITISH AND INTERNATIONAL STANDARDS
FACTORY ESTABLISHED IN TECHNICAL COLLABORATION WITH M/S. A.E.I. LTD., U.K.
Powerfully Yours
HEAVY ELECTRICALS (INDIA) LIMITED
(A Government of India Enterprise)
BHOPAL

AND NOW IT IS THREE

Those who till now have thought that the Moon is the only celestial partner the Earth has may be in for another think. Lars Danielsson of the Royal Institute of Technology, Stockholm, Sweden, and W. H. Ip of the University of California, San Diego, USA, have recently shown (*Physics Today*, *24*, 17) that an asteroid, Toro, has been carrying on a triangular affair with the Earth and its satellite for at least 200 years. And they feel the affair may last another 400 years.

They computed Toro's orbit and found it to be in consonance with the Earth-Moon system. But they aren't very sure if this triplet was born with the solar system. If it was formed at that time, Toro should provide valuable clues to the origin and development of the solar system. Toro has a period of 1·6 years. At its closest approach it is about 0·13 astronomical units from the Earth (one astronomical unit equals the average distance between the Earth and Sun — 150 million kilometres).

Two years back, Nobel Laureate Hannes Alfven and Gustaf Arrhenius, both of the University of California, San Diego, had suggested manned flights to asteroids instead of planets as asteroids would provide more pertinent information about the solar system. One theory has it that asteroids are the intermediate stage in planet formation. Thus the study of an asteroid would make clearer the



New Scientist

epoch in solar history when the planets accreted from interplanetary grains. Toro could prove a good asteroid to visit.

But Toro will not stay faithful to the Earth forever. Its harmonious balance with the Earth and Moon could well be upset by the wiles of a neighbouring planet — appropriately enough Venus.

THE ALCOHOLIC AND THE ELECTRIFIED RAT

Researchers find it difficult to use certain animals in laboratory studies on alcoholism. Especially rats. Rats seem to naturally abhor alcohol. But two groups of American neurophysiologists (M. J. Wayner and I. Greenberg at Syracuse University, and R. J. Carey and D. Notley at Syracuse Veteran's Administration Hospital at New York) have discovered that rats can be made to like alcohol.

In their report in the *Journal of Physiology and Behaviour* (7, 793), they state that the electrical stimulation of certain areas of the brain of experimental rats can make these rats develop a penchant for alcohol — in fact make them become potential alcoholics.

In animals, many unconscious activities like the initiation of thirst and appetite, temperature control and blood pressure are influenced by the hypothalamus, situated at the underside of the brain. Stimulation of the lateral hypothalamus can induce different behavioural patterns in animals. Wayner and his colleagues stimulated the lateral hypothalamus of experimental rats daily and found they avidly consumed inebriating quantities of alcohol. The rats drank for 25 days without any obvious deleterious effects. They were intoxicated — they showed the characteristic disorientation and reduced reaction to sudden stimuli so common in alcoholism. The researchers found that by stimulating the opposite side of the hypothalamus, they could induce the rats to eat well. Reduced food intake is a common result of alcoholism.

With the possibility of inducing alcoholism in rats, researchers will be able to go in for more elaborate experimental studies on alcoholism. After all, the disease aspect of alcoholism (see SCIENCE TODAY, November 1971) could do with a lot more research.

A BOON FOR THE BLIND

The OPTACON, a microminiature electronic scanner developed by engineers at Stanford University in California, USA, enables a blind person to read virtually any printed or written material without the aid of braille. The reader scans the words with the device's photo-sensitive "camera" held in one hand, while the forefinger of the other hand identifies them by means of vibrating pins that reproduce their shape. One more advance in helping the handicapped.

TWA's NEW AMBASSADOR SERVICE. SAME PRICE AS OTHER AIRLINES' ECONOMY SERVICE.

We must admit that other airlines could offer you something like TWA's new Ambassador Service.

All we did was see what our competitors were giving in terms of comfort, meals, entertainment and ground services.

Then worked all year to give you something better

Sometimes this cost a fortune (we ripped out the insides of all our 707's and renewed everything from the floor up)

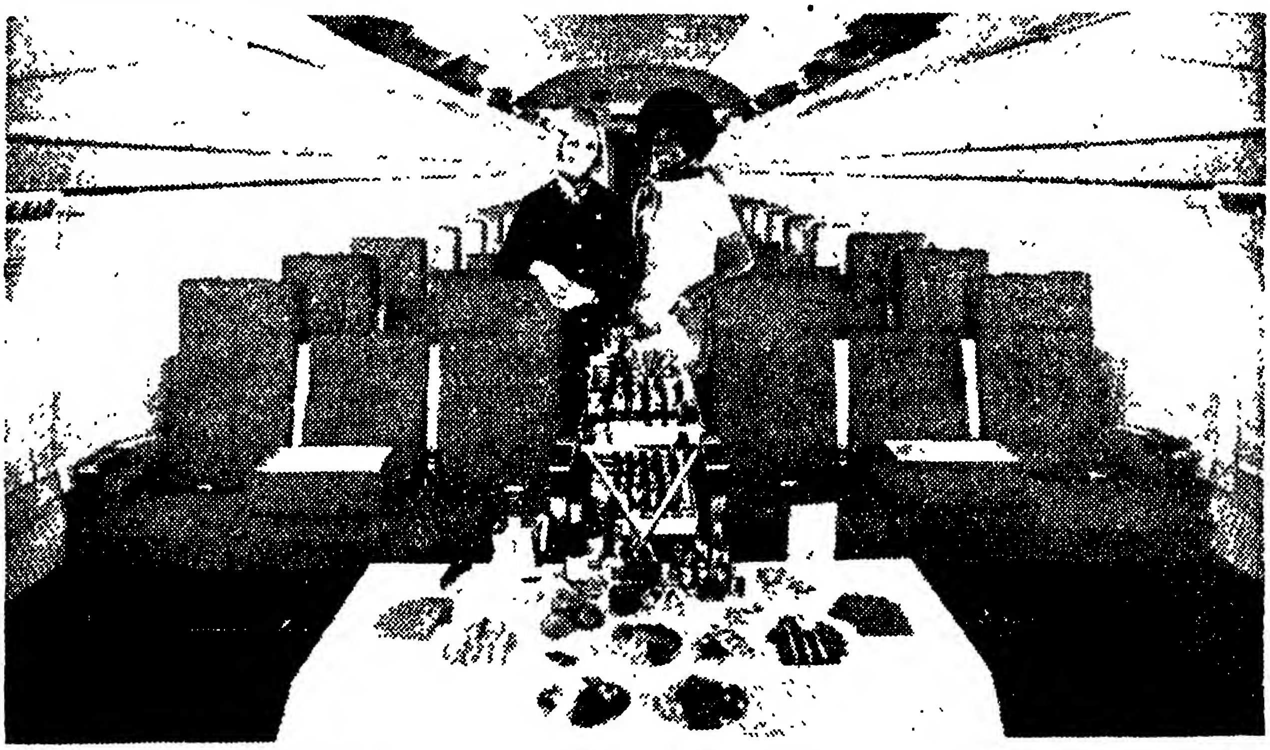
Sometimes this cost a little more trouble (offering a choice of three meals in economy rather than no choice).

And sometimes it cost nothing but a little thought (no-smoking sections, for example).

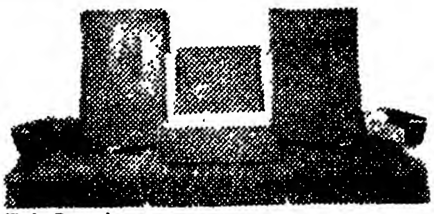
Next time you fly to America, ask your travel agent to book you a TWA Ambassador flight.

If it isn't considerably better than the service other airlines offer you, fly back with one of them

They all charge the same as TWA's new Ambassador Service.



707 Economy.

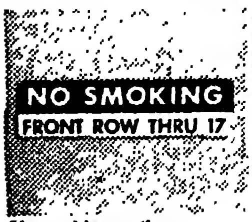


Twin Seats in economy.
Only TWA gives you this twin seat on 707's in economy It can be three across, or if the plane's not full, two across or even a couch.

The Ground Ambassador.
Whatever your problems, he'll help you from booking a car to getting a hotel to phoning your office

New uniforms for hostesses.
We've given our girls a choice of three uniforms (including hot pants) designed by Valentino. It helps.

Choice of three to five meals.
Only TWA offers you a choice of three meals in economy, five in first class



No smoking sections.
Many Ambassador features cost a fortune. This one just cost a little thought.

TWA's new terminal in New York.
For TWA passengers only. You can be through it, having cleared customs and immigration, inside twenty minutes. Most airlines still share one old terminal

Choice of films.
TWA offers you a choice of films (one for adults, one for everybody).* Most airlines still show one, or none.

TWA

THE WORLD'S LARGEST AIRLINE SERVING ASIA.

Offices in Bombay • Calcutta • Delhi Madras • Ahmedabad • Kathmandu

FA.006.72

* IATA requires us to make a nominal charge for in-flight entertainment. And for alcoholic beverages in economy class.

TEMINISM and reverse transcription are new phrases in the molecular biologists' jargon. After being branded as a heresy and consigned to the cold store for six years, Teminism became an accepted fact in 1970. And, in its wake, it brought along a whole new series of studies and some exciting developments.

What is Teminism? Why are scientists so excited about it? For a long time it was thought that genetic information in the cell is passed from DNA to RNA to protein, which are components of the cell, in a rather strictly one-way flow. This was called the central dogma of molecular biology. In 1963, Dr. Howard Temin found that RNA replication of RNA tumour viruses takes place through a DNA intermediate. It was then suggested that the RNA virus synthesised a DNA which carried the (tumour-causing) genetic information. This new DNA could get integrated in the DNA of a healthy host cell which, while proliferating by normal cell division, could carry this information from one generation to another.

For lack of proof the theory was ignored at first. In 1970, Temin himself provided evidence for the presence of a special enzyme, called reverse transcriptase, capable of transferring genetic information from RNA to DNA in the RNA tumour virus. This set the biggest bandwagon of molecular biologists on the trail of tumour viruses. By now reverse transcriptase has been traced in more than 30 RNA tumour viruses. It is also suspected to be present in human leukaemic blood, but this has not yet been proved.

We also do not yet know the exact relation between the virus and cancer. Nor do we know how the virus actually gets its genetic information integrated in the host cell. Some suggest that genes capable of causing tumours lie passively inherent in all normal cells. They are activated by viruses or environmental factors like radiation, carcinogens, etc. Temin himself thinks that tumour viruses evolve in the body itself by some random cellular reactions. And on these are centred much of the present studies. They will in course of time lead us to a better understanding of cancer and how it is caused and, maybe, to better means of controlling the disease. Here is a detailed account of these interesting developments in the last two years and the present state of studies in this field.

HUNT FOR CANCER VIRUSES

M. R. DAS

AS early as 1964 Temin suggested that RNA replication of RNA tumour viruses takes place through a DNA intermediate. His hypothesis explained several unique features of tumour-causing, or oncogenic, RNA viruses. Among these are the heritably stable transformation of normal cells into tumour cells (transformation which persists through generations) induced by these viruses, the apparent vertical transmission (from parents to progeny) of leukaemia in certain strains of mice and the requirement of DNA synthesis in the early stages of this infection. And when Temin later found the presence, in an RNA tumour virus, of a special enzyme, called RNA-instructed DNA polymerase or reverse transcriptase, which

could transfer genetic information from RNA to DNA, it provided the missing link in his hypothesis of reverse transcription. Once the RNA in the tumour virus gets transcribed into a DNA, it could get integrated into the DNA of a healthy host cell and the oncogenic information could then be passed on from parent to progeny.

Reverse transcription thus implied that viruses can be the cause of at least some types of cancer; the molecular details of possible viral oncogenesis were fascinating. The significance of the discovery of reverse transcriptase may not be, however, limited to tumour virology. If this enzyme played an important role in cell transformation, it could, perhaps, have some role in the differentiation of embryonic tissues too. Besides, it could also be significant in problems of cellular regulation in mammalian cells.

These were very significant implications. They set off a burst of activity in the field of tumour virology and biochemistry. And within a few days after Temin reported his findings in May 1970, Spiegelman and his group, working at Columbia University, USA, confirmed the existence of reverse transcriptase in several RNA tumour viruses and showed that the nucleic acid synthesised by the enzyme reactions is a true hetero polymer incorporating all four bases of DNA — adenine (A), thymine (T), cytosine (C) and guanine (G). In other words, it was a true DNA. But this did not establish its relation to the life history of the virus. The question was whether the sequence of the four bases in the DNA synthesised was related to the RNA of the virus. Molecular hybridisation experiments showed that this was indeed so (see SCIENCE TODAY, December 1970).

Thereafter the progress was rapid. By now more than 30 RNA tumour viruses that cause leukaemias, mammary carcinomas, and sarcomas in chicken, mice, rats and monkeys have been found to contain reverse transcriptase. And none of the non-tumour viruses like the Newcastle disease, influenza, polio or reo viruses showed reverse transcriptase. There were, however, two exceptions—visna virus which is a neurotropic agent isolated from the brains of neurologically afflicted sheep and progressive pneumonia virus which causes a slowly evolving disease in sheep lungs. These two were found to have reverse transcriptase activity, but then it was found that these viruses did possess previously unsuspected oncogenic potential. Takemoto and Stone recently demonstrated that they transform cells in laboratory conditions too.

The clinical manifestations of visna infection are similar to those of multiple sclerosis in man. Such neurological signs appear only months or years after viral infection. But once clinical signs appear, the disease progresses to paralysis and death. The observation of Takemoto and Stone suggests that the visna is one of a group of slow viral agents that share common characteristics with RNA tumour viruses and have oncogenic potential. Using the available information on the biological and chemical properties of the visna virus, it may be possible to incriminate similar agents which cause currently undefined human neurological diseases.

The role of reverse transcriptase

On the role of reverse transcriptase in cell transformation, some interesting findings came from Hanafusa's group at the Public Health Research Institute, New York. They had isolated a variant of the Rous Sarcoma Virus (RSV which causes cancer in chicken) which appeared to be uninfectious. Neither could it transform chick fibroblast cells in culture, nor did it show reverse transcriptase activity. The group went one step ahead and did a mixed infection experiment. They infected chick fibroblast with the variant RSV strain and an avian leukaemia virus (ALV) which possesses reverse transcriptase activity and which can replicate in the fibroblast cells but cannot transform them. The result was that the cells were transformed into tumour cells, but without yielding infectious progeny. Thus, although the uninfectious strain of RSV could make use of the reverse transcriptase from the ALV for transformation, the system cannot yield infectious RSV as the sarcoma virus genome cannot specify its own reverse transcriptase. Studies by Martin's group in Berkeley, USA, using temperature-sensitive mutants, showed that the viral RNA genome is required for cell transformation and the *maintenance* of the transformed state. Results of *in vivo* experiments using the temperature-sensitive mutants coupled with reverse transcriptase assay would be highly interesting.

The implications of the findings now become obvious. If reverse transcriptase is responsible for the induction and maintenance of cancer in cells, can drugs control its action? A search is on for drugs which can inhibit this action

Some Basic Findings

CAN RNA-instructed DNA polymerase initiate DNA synthesis unaided by a primer? It has been recently shown by Baltimore and colleagues that reverse transcriptase is in fact similar to Konberg DNA polymerase I and requires a small RNA primer on which initiation of the DNA takes place. It has also been reported by Molling and his colleagues from Tubingen that at least the avian myeloblastosis virus contains a ribonuclease H activity associated with reverse transcriptase.

Spiegelman's group has reported the purification of the RNA-instructed DNA polymerase from avian myeloblastosis virus by a combination of column chromatography and gel filtration methods. The purified enzyme consists of two sub-units of molecular weights 110,000 and 69,000. The purified enzyme has all the three, RNA-, DNA- and hybrid-directed, activities but has no endonuclease activity. New experiments have also been reported from this group to distinguish a true reverse transcriptase from other DNA polymerases. Other than using a purified single-stranded RNA and looking for its template activity, it is proposed that a preferred copying of the oligomer-homopolymer complex $(dT)_{10}$: poly rA to $(dT)_{10}$: poly dA could be used for diagnosis. Only reverse transcriptase shows a preference to $(dT)_{10}$: poly rA and this method is more sensitive than following up the copying of a single-stranded RNA.

The purified reverse transcriptase has also been used for a different type of experiment. The question was asked whether the purified enzyme could be used as a general tool for synthesising DNA components of a variety of natural RNAs. It has been observed that this is indeed possible and that the AMV polymerase can copy widely different RNAs like Qβ and Maloney Sarcoma Virus RNA in addition to AMV RNA. Thus, given a purified RNA message, it seems possible to synthesise the corresponding genetic material.

DNA products synthesised in this manner can be put to several useful experiments. Radioactively labelled DNA of this type can be used as an analytical probe for the corresponding gene in the host chromosome or for its message in a mixture of RNA molecules by molecular hybridisation experiments. It is also obvious that this procedure eliminates the necessity of individually isolating reverse transcriptase from different RNA viruses. It is appropriate to quote Spiegelman in this context: "The ability of one enzyme to accept a variety of oncogenic RNAs will obviate many of the logistical difficulties that arise, particularly in attempting to illuminate the aetiology of human cancer . . . The reverse transcriptase method for the synthesis of DNA copies of RNA cannot replace the elegant chemical approach of Khorana and his colleagues. But it could provide a convenient and rapid supplement in instances in which detailed knowledge of sequence is not pertinent."

selectively without injuring the cells. What would be the effect of these drugs *in vivo*? Brockman and his colleagues have shown that streptovaracins can block reverse transcriptase activity and prevent the transformation of mouse fibroblast cells by mouse sarcoma viruses. It has also been shown that streptovaracins delay the induction of leukaemia in mice by murine leukaemia viruses. A large number of rifampicin derivatives are also being screened in several laboratories.

The role of other enzymes

The heritably stable state that characterises cells transformed by tumour viruses would appear to require the integration of the newly synthesised DNA to the genome (genetic material) of the healthy cell. What would be the mechanism of events leading to this? Soon after the discovery of reverse transcriptase, Spiegelman and his collaborators showed that in addition to the RNA-instructed DNA polymerase (reverse transcriptase — it uses RNA as template for DNA synthesis), RNA tumour viruses possess two other enzymes — one which uses a DNA-RNA hybrid as template and the other which uses a DNA-DNA duplex as template. These findings have led to the postulation of a sequence of events that takes place after infection by an RNA tumour virus.

This sequence is shown on page 16. First, the reverse transcriptase makes a single-stranded DNA. This is converted to a double-stranded DNA by the hybrid-instructed enzyme. Probably these 'oncogenes' or DNA pieces containing the oncogenic information from the viral RNA are amplified by the DNA-instructed DNA polymerase. This could provide a large number of

copies of the DNA and could facilitate its integration into the host cell genome. Temin has also reported the presence of a DNA ligase, an enzyme that patches up DNA pieces, in RSV in addition to the three DNA polymerising enzymes mentioned above. It is thought that the function of this enzyme is to integrate the 'oncogenic' DNA into the DNA in the chromosome of the healthy host cell.

Human cancer virus?

Spiegelman's and Temin's groups had also found that reverse transcriptase preferred synthetic DNA-RNA hybrids and some synthetic RNA-RNA duplexes to resident viral RNA as templates for DNA synthesis. This gave rise to the hope that these synthetic templates could be used to detect the presence of small amounts of reverse transcriptase. And if there is a human cancer virus present, the way now seemed open for pinning it down. There was indeed some excitement when the presence of reverse transcriptase was suspected in human leukaemic cells using this method. But soon it was observed that, using the same method, "reverse transcriptase" could be found in normal cells too. However, careful experiments by Spiegelman's group, and later by Todaro's group, showed that in general, many synthetic RNA duplexes and hybrids are not specific templates for reverse transcriptase, although a specific synthetic hybrid like dT: rA is helpful in detecting the enzyme (see box on basic findings). Synthetic templates are, no doubt, of great use in characterising and following up reverse transcriptase activity once its presence is proven with a natural RNA template (incorporating all the four deoxy ribo nucleoside triphosphate components in the DNA product).

However, the hope of finding a reverse transcriptase in human leukaemia has now been

Schematic representation of the sequence of events after infection by RNA tumour viruses. 4 dNTP refers to the four deoxy ribo nucleoside triphosphate components of DNA. RIP is RNA-instructed polymerase. HIP is hybrid-instructed polymerase. DIP is DNA-instructed polymerase

$$\text{VIRAL RNA} \xrightarrow[\text{4 dNTP}]{\text{RIP}} \text{DNA : RNA HYBRID}$$

$$\text{DNA : RNA HYBRID} \xrightarrow[\text{4 dNTP}]{\text{HIP}} \text{DNA : DNA DUPLEX}$$

$$\text{DNA : DNA DUPLEX} \xrightarrow[\text{4 dNTP}]{\text{DIP}} \text{MORE COPIES OF DNA : DNA DUPLEX FOR INTEGRATION}$$

What Causes Cancer?

THE ONCOGENE AND THE PROTOVIRUS THEORIES

THE term 'oncogene' is rather loosely used in this article. This is a term introduced by Robert Huebner of the National Institutes of Health, US, in his oncogene theory of the cause of cancer. Though RNA tumour viruses can infect susceptible animals and cause a transformation of susceptible cells, very few cancers have epidemiological characteristics of an infectious disease. Huebner and his colleague George Todaro have therefore postulated that the viral information (the virogene), including that portion responsible for transforming a normal cell into a tumour cell (the oncogene), is usually transmitted from a parent animal to its progeny and from a parent cell to its progeny in a covert form. In other words, genes capable of causing malignant cell transformation are part of every animal's genetic make-up. Carcinogens, irradiation and the normal ageing process favour the partial or complete activation of these genes. Such a hypothesis is, however, not amenable to rigorous experimentation. But studies in the laboratories of Hanafusa, Vogt and Weiss last year have provided interesting evidence in support of Huebner's theory — they isolated an avian leukaemia-type virus from the cells of healthy chick embryos. It has also been possible to induce the production of this virus in cell cultures. This observation suggests that normal birds have the genetic potential to specify an avian leukaemia virus.

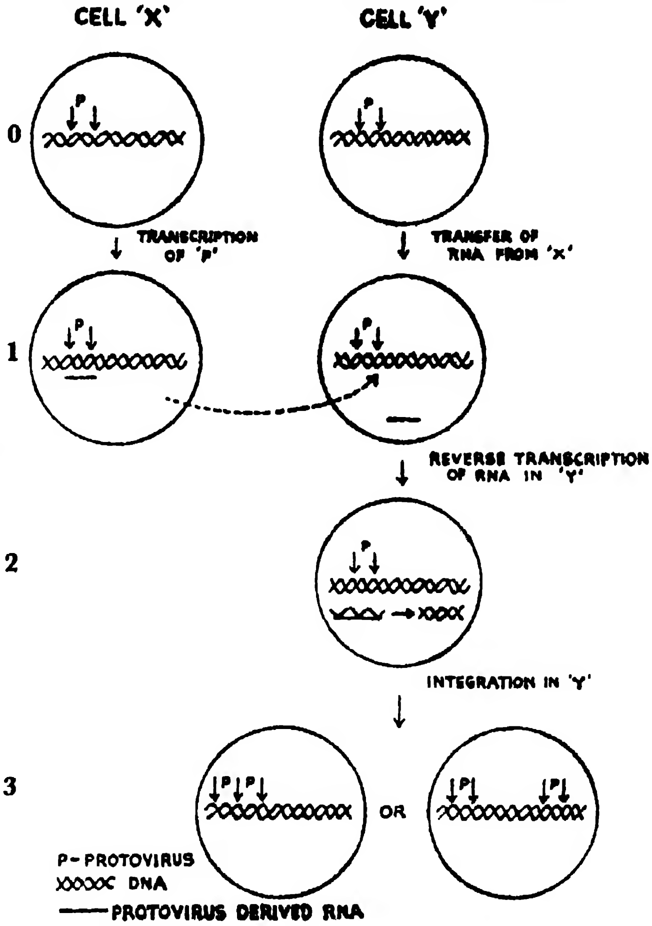
More recently, Temin has come out with what is known as the protovirus theory. It makes use of a mechanism different from the one suggested by Huebner and Todaro for the evolution of the virus. According to the oncogene theory, the appearance, for example, of a leukaemia virus results from a non-genetic change by the activation of repressed provirus (or oncogenes). According to the protovirus theory, there is no necessity for

the existence of the leukaemia virus in every cell. It evolves from protoviruses by genetic change. Temin postulates that protoviruses would be genetic systems transmitting information from DNA to RNA and back again to DNA. These would be capable of passing from one cell to another in an organism either as free RNA or as an RNA-protein complex.

In the evolution of a complete RNA virus, the DNA protovirus in one cell ('X' in the figure) would act as a template for the synthesis of an RNA copy which would then go to another cell ('Y' in the figure) and act as a template for a DNA copy. The new DNA copy would become incorporated in the genomic DNA of the second cell. The incorporation could be either at the site of the original protovirus DNA, causing a duplication, or at another site, causing an insertion (see figure). The site of integration becomes extremely important in determining the physiological evolution of the virus. The integration of the protovirus-derived DNA next to a region controlling, for example, cell membranes could affect the surface properties of the cell. (Notice that healthy cells when grown in tissue culture cease to multiply when the number of cells reaches a stage where the cells come fairly close to each other. This is known as contact inhibition. Transformed cells—cancerous—do not have this contact inhibition. The surface specificities are changed and they can go on multiplying even when the cells are in contact with each other.) Similarly, integration in some other region could affect the multiplication control of the cell. Continued evolution in this manner could put together in a contiguous region of the chromosome the information necessary for the formation of a completed virus particle.

However, according to the protovirus theory, the complete evolution of the virus is not a prerequisite for cancer. If a protovirus were altered either spontaneously or by the action of a carcinogen, so that it produced, for example, a protein that altered a cell's surface properties and its response to multiplication controls, a tumour would result. If this change occurred before the protovirus had developed a protein coat, the cancer would not contain the genetic information for producing a completed virus particle. In principle, according to this theory, a carcinogen would be causing a mutation in a protovirus, perhaps, by affecting some step in the transfer of information from DNA to RNA, or in reverse transcription, or in DNA integration.

But it should be particularly emphasised that both the oncogene theory and the protovirus theory are still hypotheses, many features of which remain to be tested.



A possible sequence in protovirus evolution. At times 'O' cells 'X' and 'Y' can be identical. 1. Transcription of RNA from the protovirus region of cell 'X' followed by the transfer of RNA to cell 'Y'. 2. Reverse transcription of protovirus-derived RNA. 3. Cell 'Y' after integration of the newly synthesised DNA. The new DNA could either integrate in a region contiguous to 'P' or in a different region

revived. The buffy coats isolated from a large number of human leukaemic blood samples showed considerable reverse transcriptase activity (detected by the synthetic template dT : rA). In normal blood samples, this activity was negligible. In fact, Spiegelman's group diagnosed 24 of the 25 cases of leukaemia, and in one case corrected a false diagnosis. However, it was not possible to demonstrate the synthesis of DNA using natural RNA as template.

It appears that the difficulty in establishing conclusively the presence of a " true reverse transcriptase " is because the enzyme is present in very small amounts and is contaminated by other DNA polymerising enzymes. Experiments on chicken leukaemia indicate this. For instance, the avian myeloblastosis virus (AMV) purified from blood plasma was one of the first viruses in which reverse transcriptase was detected. But if one examines the myeloblast cells from chicken infected with this virus (a procedure equivalent to examining the buffy coats in human leukaemic blood) no " true reverse transcriptase" activity, i e DNA synthesis using a natural RNA template, can be detected. At the same time, like the buffy coats, the myeloblast cells showed high enzyme activity when tested with synthetic dT : rA templates. But when the dT : rA enzyme activity from myeloblast cells was followed up and the enzyme purified to a high degree, it showed DNA synthesis on a natural RNA template. It thus appears by analogy that if the enzyme found in leukaemic buffy coats is purified to a high degree, it might be possible to establish the presence of reverse transcriptase. The ability to predict a relapse of leukaemia by detecting the reappearance of response to the dT : rA template in blood offers a clinical advantage. The enzyme cannot be detected for patients in remission.

Milk virus particles

There is enormous current interest in a virus-like (" B-type ") particle that has been observed in human milk. Dan Moore and his collaborators in Camden, New Jersey, Detroit, Michigan, and at the Tata Memorial Centre, Bombay, have detected a virus in samples of human milk which closely resembles the mouse mammary tumour virus or the Bittner virus (see SCIENCE TODAY, May 1971). Schlom, Spiegelman and Moore soon found that the particles contained reverse transcriptase which can use the resident "viral" RNA as template.

The developments were so rapid that Moore, with support from the NIH, arranged an international meeting on mammary neoplasia in Camden (USA) in November 1971. Here it was pointed out that the earlier statistics on the percentage of the occurrence of particles in samples may not be correct owing to the small number of samples examined in some cases. Further, a careful examination of the electron micrograph pictures has revealed that not all the particles are truly B-type. Only some are true B-type particles, with a head, a tail and spikes. Some, with head and tail but no spikes, resemble more C-particles. The third group has neither tail nor spikes. This fine division in the morphology of particles showed that all samples of milk containing one or the other type of particles do not necessarily contain reverse transcriptase as reported earlier, though most of the samples were enzyme positive. For the present, what one can safely say is that all milk samples with reverse transcriptase contain one or the other, or more than one type of particles. A more concrete result perhaps is that some of the enzyme-containing samples were found to contain a 70S RNA (high molecular weight RNA) on which nascent DNA synthesis was taking place. The presence of a high molecular weight RNA sedimenting around the 70S region is typical of RNA tumour viruses.

Although there is thus circumstancial evidence that the milk particles may be a necessary but not a sufficient condition for mammary neoplasia, there is no direct evidence yet that they can cause cancer. A good deal of immunological investigations and experiments to show that these particles can transform healthy cells in culture into tumour cells or induce tumours in animals are required before implicating a tumour virus as responsible for human breast cancer. And it is too premature to predict the possibility of vaccination against such a virus as some groups of investigators tend to think.

Meanwhile, there has been a very interesting development in the Bittner virus story itself. In molecular hybridisation experiments, the DNA product obtained from reverse transcriptase in mouse milk particles showed homology with the RNA from nuclear and polyribosomal fractions (polyribosomes are ribosomes actively engaged in protein synthesis) of tumour cells. The result implies that the viral RNA serves as messenger RNA for directing the synthesis of proteins required for virus production and perhaps the maintenance of the transformed or neoplastic state. The technology developed for these types of experiments is immediately applicable to tumours of human origin. It has, in fact, been reported by Axel, Schlom and Spiegelman early January this year that the DNA product from the Bittner virus hybridises to 19 out of 28 polyribosomal RNAs from human breast cancer. RNAs from normal breast tissues or from benign tumours do not hybridise with this product. Experiments involving product DNA from human milk particles are under progress in a few laboratories. The outcome would be highly interesting.

MARS IS IT ALIVE?

V. S. VENKATAVARADAN

IS there life on Mars? We don't know yet. But its surface is alive. Ice caps form in the polar regions during the winter and melt and shrink during the summer. There are dark regions on the surface which show activity with the climatic cycle, regions which change their colour when the polar ice melts. White and blue clouds form in the atmosphere and occasionally dust storms swirl about.

But there is a more exciting possibility: Mars could be a dwelling place for extra-terrestrial life. It is probable that in the universe there may be quite a large number of planets where conditions favourable for life exist. But do such conditions exist in our neighbourhood in the solar system? Life as we know it on Earth is essentially constrained by stringent temperature and atmospheric conditions. The analysis of lunar samples from the Apollo and Luna missions have conclusively proved that there is no life on Moon. What about the Earth's two nearest neighbours — Venus and Mars? Venus may be a little too hot and Mars a little too cold.

Mars might yet hold life as it is a planet similar to Earth in many aspects (Table 1). There are two factors that support this assumption: the climatic variations in the dark regions which are attributed to vegetation and the existence of straight rilles (some of them supposedly connecting the dark regions with the red desert regions) which could be attributed to intelligent life.

Most of the astronomical information about Mars was known long before the advent of space research. Mars is solid throughout unlike Earth which has a liquid core. (This is supported by the absence of magnetic fields as measured by Mariner magnetometers.) This is a consequence of its smaller mass — one tenth that of Earth. Its diameter is nearly half the Earth's and its surface gravity a little over a third. The length of the day and the inclination of the axis of rotation to the orbital plane are about the same for both. (It is not known whether this is just coincidence or whether there is some connection between Mars and Earth, perhaps extending back to the origin of the solar system).

The whitish polar caps, the most conspicuous of all martian features, display a regular seasonal cycle. (The weather and climatic pattern on Mars and Earth are similar. This is because, as mentioned earlier, the length of the day and the inclination of the axis of rotation are nearly equal, except that the martian year is nearly twice the terrestrial year. Even though the proportion of winter in a year for both Earth and Mars would be same, the length of the winter in Mars is about 200 days). During spring and early summer, the polar cap shrinks rapidly. Like on the Earth, the summer and winter for the southern and northern hemispheres are complementary. In early northern summer, for instance, the snow melts and the vapour is quickly transported to the equator from where it goes to the south pole to build the southern winter cap. The thickness of polar ice on Earth goes down to many metres while on Mars it cannot be more than a few centimetres. This is deduced from the rapid rate at which the caps shrink with the available sunlight.

COMPARISON OF EARTH AND MARS

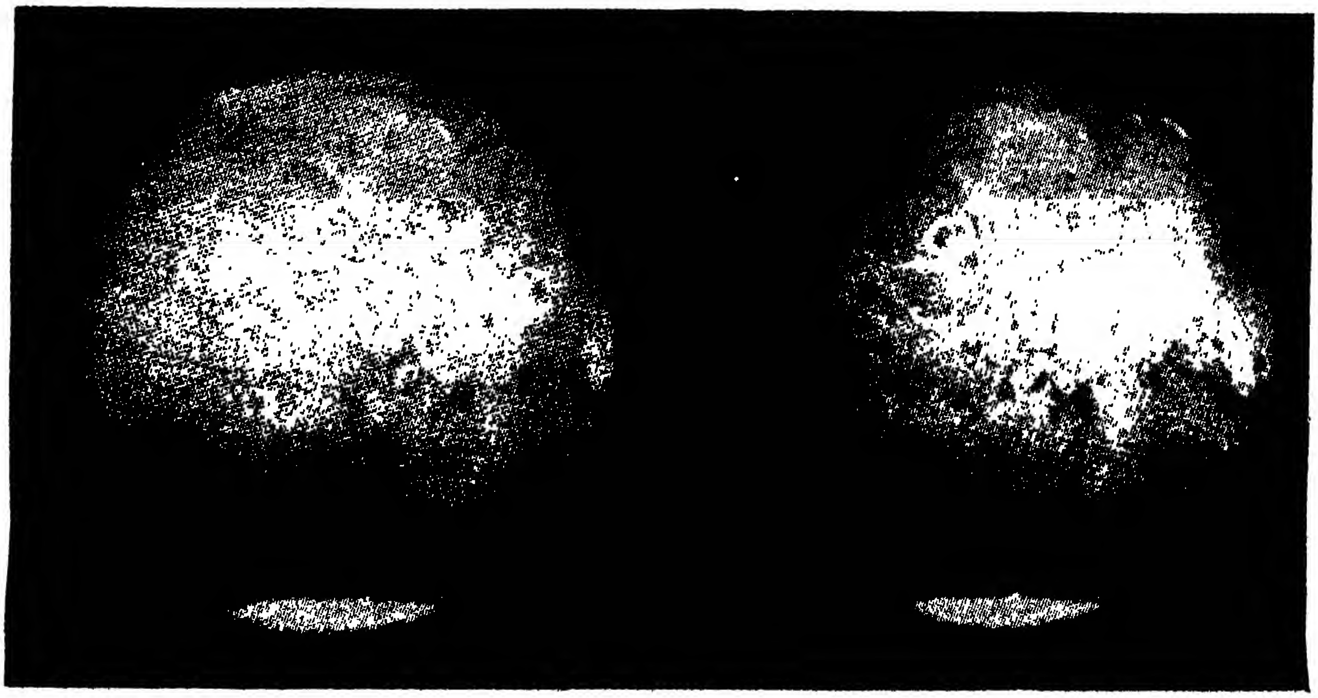
	Earth	Mars
Mass	1	0·1
Mean density	5·5	3·8
Mean diameter	12,670 km	6,750 km
Gravity	1	0·4
Length of the year	365 days	687 days
Day length	23 hr 56 min	24 hr 37 min
Distance from Sun	148,800,000 km	226,720,000 km
Moons	1	2

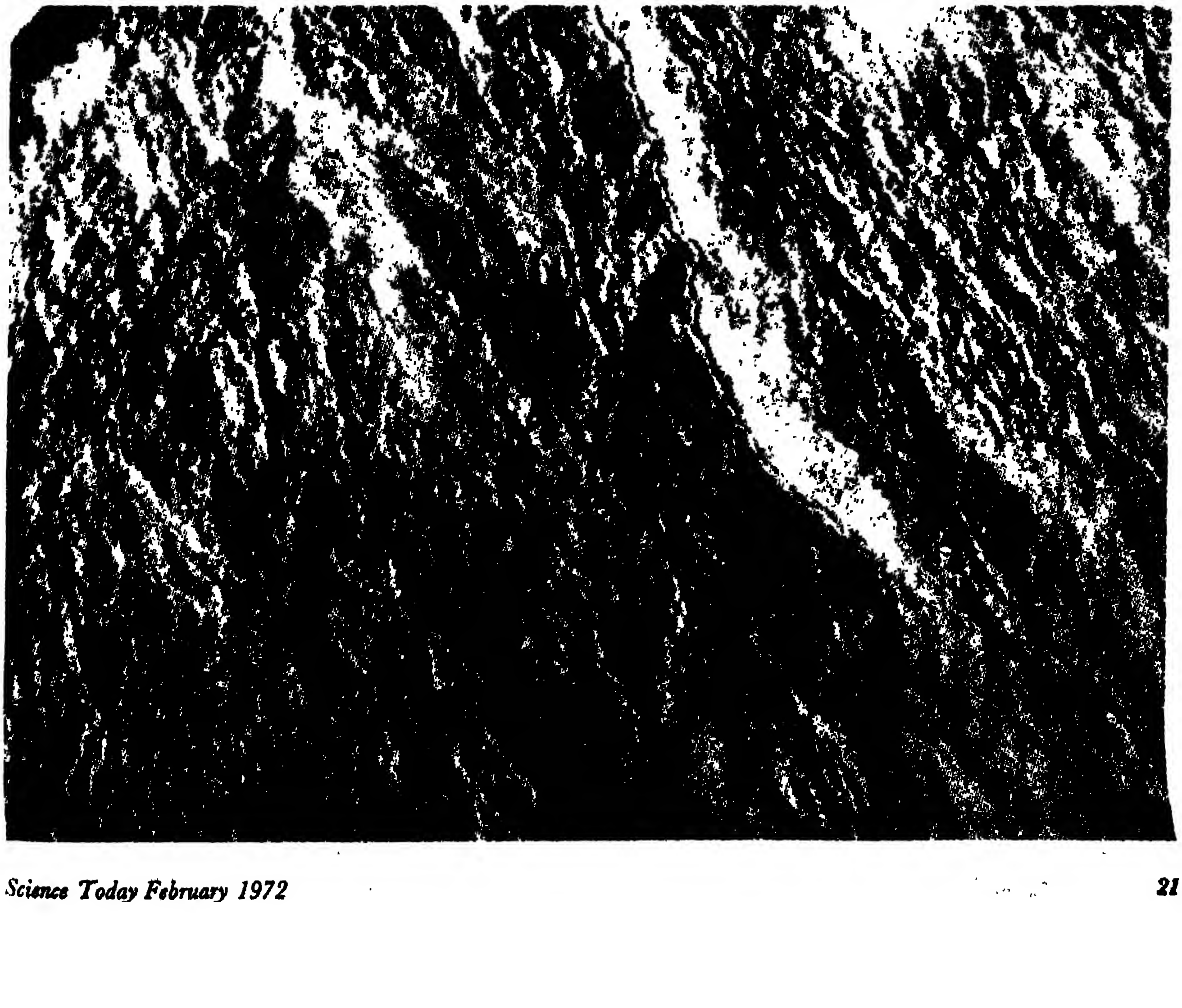
The polar deposits may be made up of both water and solid carbon dioxide. During the summer, when the polar cap shrinks, a dark fringe appears along the edge of the cap. This is possibly due to the moistening of the land around the receding ice caps. In the polar regions one also sees local bright spots where the ice lasts longer. These spots occur due to the recondensation of vapour at higher elevations from the ground.

Facing page: Clearing of dust on surface of Mars is evident in these two Mariner 9 photographs on the Nix Olympica region taken 5 minutes apart. Wide-angle photo (above) shows an area 435 km by 555 km. Narrow-angle photo (below), covering a 43 km by 56 km area, is close-up of area shown in rectangle and has features similar in appearance to those seen on lava flows on Earth. Texture and numerous small intersecting elongated lobes indicate possible flow of material downslope and away from central crater complex. Note raised ridge with irregular crack along crest. Craters in top photo appear to lie atop broad plateau

By far the most striking evidence for the possibility of life on Mars comes from the climatic variations of the dark green regions which are concentrated in the equatorial parts. The most noticeable dark areas are *Syrtis Major* in the southern hemisphere and *Mare Acidalium* in the northern hemisphere. When the polar ice melts, these regions show a deepening of colour — the dark regions grow still darker — typical of vegetation which grow in the presence of water in the atmosphere.

Martian south polar cap photographed by Mariner 7 is probably frozen carbon dioxide, because (according to JPL scientists) there is not that much water on Mars to make that much real snow. The ring seen near top centre is the outer rim of the Nix Olympica region, the area Mariner 9 has extensively photographed (facing page) during its recent orbital flights. Nix Olympica had been seen earlier through telescopes on Earth as a spot whose brightness increased in the martian afternoon, but whose nature was a complete mystery. (The two photographs were sequence shots, taken at an interval of 47 minutes during which time Mars rotated through an angle of 12 degrees)





poking through the dust cover. Dust storm has obscured an outer ring seen in Mariner 6 and 7 flights two years ago (see photo on page 20). Photo above, left, shows a crater near Nodus Gordic which is about 112 km in diameter or equal in size to the largest comparable feature on Earth or the Moon. The multiple concentric fractures on the eastern rim and the numerous rimless smaller craters suggest that this is a caldera or a crater created by volcanic collapse

Photo above, right, shows part of a system of martian rilles, 1,800 km long, photographed in the Mare Sirenum by Mariner 9 from 1,700 km altitude. Like the rilles on the Moon, these too may be tensional features. The widest shown here is about 1·6 km across and contains a secondary rille within it

Computer-enhanced photographs sent by Mariner 9 have shown crater rims similar to collapsed craters found on terrestrial volcanoes. The photograph below shows a complex crater in the Nix Olympica area. The crater, about 64 km in diameter, is in a high region of the martian surface

Above: Stream-like erosional pattern resembling that on Earth is seen in this Mariner 9 photograph of plateau walls rimming an 80 km-wide down-faulted valley on Mars. NASA's Jet Propulsion Laboratory scientists say the resemblance to terrestrial patterns is probably superficial since some of the branching canyons are actually closed depressions. One explanation can be volcanic-caused subsidence of the crust and erosion by martian winds. There is another interpretation. Canyons filled with debris at their mouths are typical signs of stream erosion. The pattern resembles erosion on arid or desert regions on Earth where infrequent but sometimes heavy rains scour tree-branch-like canyons in highlands that remain dry otherwise. Such stream outwash also creates large alluvial fans of sand and soil on valley floors around canyon mouths. A fluted central ridge in martian valley floor loosely parallels valley rim. Arrows (right) mark a long crater-chain similar to those found on Moon, believed to be result of venting through a crustal structure. The location is a valley in Tithonius Lacus, 500 km south of martian equator

Above: Profusion of craters on Phobos, one of the two martian moons, suggests the satellite is very old, having been struck by numerous objects through time, possibly fragments from asteroids. Phobos is estimated to be about 21 km high, 25 km long and having a low gravity — 1,000th that of Earth's — which permits it to retain its oblong shape. (Photo taken from 5,540 km distance)

In terrestrial plants, the green colour is imparted by chlorophyll which aids in the conversion of the solar energy into chemical energy (photosynthesis). From an analysis of the reflected solar light one can, to some extent, understand the nature of the substance. For instance, chlorophyll when seen by reflected solar light is moderately intense in the violet, blue and blue-green rays — but it is very strong in the yellow-green and yellow rays, weak in the red and extremely strong in the infra-red. An observation of the dark martian regions, however, shows them to be strong in violet, blue and blue-green light but weak in yellow, orange and red. The substance responsible for the so-called regions of vegetation, therefore, does not possess chlorophyll. This in itself cannot rule out the possibility of a different kind of " vegetation " on the martian surface. It only proves that if it exists, it is not of the terrestrial type.

The other prominent regions on the surface of Mars — the bright deserts — have the same colour as the common terrestrial igneous rock, *rhyolite*. As mentioned earlier, there are a number of rilles, some of them connecting the dark regions with the red desert regions. This was taken as evidence of the intelligence of the Martians in building systems of canals for irrigating their desert lands. However, the observations that these are straight canals are in dispute. While the famed astronomer Percival Lowell supports the theory of rilles, there are some who call the theory psychophysical rather than astronomical.

The atmosphere of Mars is much less dense than ours. From an analysis by Mariner IV, it was concluded that the martian atmospheric pressure is about 1/100 the terrestrial atmospheric pressure. The major component is carbon dioxide as most of the water would have solidified under the prevailing low temperature. Hence water vapour is present to a lesser extent. The search for oxygen of course has proved futile. But again this may not preclude the possibility of life.

The solar radiation received in the region of Mars is less than half that received near the Earth. This, coupled with the fact that the martian atmosphere is very thin, makes the temperature very low. The yearly average temperature over the globe is — 20°C. On the equator at day time it is as high as + 30°C while the nights, even at the equator, are very cold. At sunrise the equatorial regions record a temperature of around — 50°C. The minimum temperature in the polar region is around — 90°C.

Despite the low temperature and an atmosphere of carbon dioxide with small amounts of water vapour, martian conditions are similar to those encountered in the frozen lakes of the Anatarctic where microbial life has been detected. In a laboratory simulated atmosphere of Mars (with ultraviolet bombardment) certain microorganisms survived. It has been found that blue-green algae have tolerance to extreme environmental conditions.

There are well-known cloud formations in the martian atmosphere. These occur because of ice crystals at high altitudes (like in terrestrial clouds). There is also the formation of blue clouds at the equator at rising and setting limbs. But the most interesting, though rare, feature are the dust storms. In 1911, for instance, there was a vast cloud that hung over much of the southern hemisphere and persisted for months. Since the winds on Mars are not capable of raising such giant dust storms, their origin is

Is Mars losing water?

New data analysed from the Mariner 9 findings indicate that Mars is losing something like 380,000 litres of water a day from its atmosphere. According to Mariner project scientists, the water vapour may be from gases vented from deep within the planet by volcanic action. The escaping water vapour, plus considerably greater amounts of carbon dioxide from the south polar ice cap, forms a deck of white clouds high in the martian stratosphere and individual cloud puffs at much lower altitudes.

" The exciting thing is the discovery of volcanoes ", said Dr. Harold Masursky, team-leader for TV experiments aboard Mariner 9. " It means Mars is much more active (geologically) than the Moon, but less than Earth." This will help future site selection for instrument landers. Areas can be chosen with clear indications of erosion that may have been caused by movement of liquids rather than by wind.

Water is considered essential for most known life-forms. " In that sense, in proving that life-forms exist or do not exist on Mars, Viking's (the planned 1975 mission to Mars to land instruments) chances of success are enormously improved ", Dr. Masursky said.

not yet well understood. Maybe being very close to the asteroidal belt — which is the source of meteorites — Mars might be bombarded by huge meteorites that raise such dust storms. Since the dust storms occur almost exclusively during the perihelion passage, some sort of tidal effects could also be responsible for the dust storms. The dust does not reach great heights — clear clouds can be seen in the overlying layers. After the disappearance of the dust storm, telescopic observations show a reduced brightness in the polar regions as if they were polluted by the dust.

Since the water vapour content of the martian atmosphere is very small compared to the terrestrial atmosphere (less by a factor of more than 100) there is no question of rainfall on Mars.

To sum up the situation on Mars: Here we have a planet which is very cold, without much water, without oxygen, with a very thin atmosphere which lets in lethal ultraviolet rays from the Sun. Any one of these characteristics may make the existence of life as we know it on Earth difficult. Could life still be possible on Mars?

To answer this question, one must know how life evolved on Earth? Without going into too many details, one can say that life evolved from the basic elements — which were essentially synthesised in the interiors of stars in both quiet and catastrophic processes — that constituted the primitive planet. Certain favourable conditions resulted in the formation of organic compounds. Later, microorganisms evolved from these compounds. Further innumerable evolutionary processes brought in the higher forms of life. At any one of these intermediate stages an unfavourable condition could have terminated the chain. What could we call these favourable conditions? Are they just *chances*? They might perhaps be called *resonances*: the system, if it is in tune with nature, resonates and goes to the next stage in evolution. If there is no resonance, there is no evolution.

Back to the problem of Mars. We can pose the question: is the environment on Mars capable of resonating a system to ultimately evolve life? The answer: It is not improbable. However, the concept of resonance is valid not only for evolving living systems but for inanimate things as well. There could be a world with roaring oceans, tropical storms and summer rains but with no life. Yet the formation of these things themselves are due to a resonance of a type where life does not enter. Is life so important that it should enter all these systems? Maybe yes, maybe no.

There are many experiments planned to test the existence of life on Mars. These include what is known as the " automated biological laboratory ". This consists in landing a nutrient medium on Mars, injecting it with samples of martian soil and then looking for signs of growth. The medium may become turbid from biological activity or may turn acidic. The evolution of carbon dioxide may also be tested. Another method consists in looking for enzymes typical of life processes. This, though involved, may be carried out with success.

Already, recent observations by the Mariners and the Russian Mars probes have given valuable informations. And, no doubt, future missions will conclusively prove the existence or non existence of life on Mars. The recovery of Mars samples by the method similar to that used in Luna 16 may also be attempted though this would be at the risk of serious hazards from martian microorganisms. Finally, man might land on Mars in the near future. When he does, will he meet a delightful creature who will receive him with a cup of water?

ROUND-UP OF RESEARCH

Lymphocyte Cooperation

LYMPHOCYTES, the major cell type of the vertebrate immunity system, are produced by the thymus, bone marrow, spleen and lymph nodes. In the early days of immunology it was believed that antibodies were the only agents acting against foreign bodies in a disease. Now it is known that antibody secretions are primarily due to lymphocytes which originate in the bone marrow (B cells); in fact, B lymphocytes constitute the parent cells for clones of antibody secreting cells.

Immunologists soon realised that foreign bodies are not only destroyed by antibodies but also by thymus-dependent lymphocytes (T cells). It was also found that T cells, besides being primary mediators of immunity, were also required for the production of antibodies by B cells. Drs. H. W. Kreth and A. R. Williamson of the National Institute for Medical Research, Mill Hill, London, UK, have now, in an article in *Nature* (*234*, 454, 24 December 1971), proposed a model to explain the role of T cells in cooperating with B cells for antibody production.

Cooperation between T and B cells has been studied in the past using many antigens — substances introduced into the blood to stimulate the production of antibodies. From these studies it has been concluded that T cells are antigen-specific.

In the present experiments, the British scientists isolated clones of B cells, referred to as W_1, by transferring spleen cells from mice which had been immunised with the antigen DNP-BGG (dinitrophenyl-bovine gamma globulin) into irradiated, genetically similar CBA mice and injecting them with the antigen again. This procedure was repeated through four generations. It was found that the clones produced a homogeneous antibody. The clone W_1 was highly antigen-specific. With DNP-BGG only 1 μg was needed to elicit maximal W_1 antibody production (1 to 2 mg antibody per cc of serum). By contrast, even with 10μg of DNP-OA (dinitrophenyl-ovalbumin) immunogen no production of W_1 antibody was observed. Antigen specificity in the response of W_1 cells has been explained previously as due to a requirement of antigen-specific T cells.

Drs. Kreth and Williamson now show that this may not be true. In their experiments they used spleen cells from a line of mice known as AKR, admixed with spleen cells from CBA mice containing W_1 cells. When 6×10^6 spleen cells from CBA mice and 10^6 normal AKR spleen cells were injected together with 10μg of DNP-OA into each irradiated CBA recipient, a production of anti-DNP antibody was observed. The results indicated that the T cell component of the AKR spleen cells can substitute for antigen-specific T cells, and their reaction with CBA B cells provides the stimulus for antibody production. However, this stimulus does not override the need for specific antigen stimulus as there is no antibody in the absence of DNP-OA.

The British scientists have also shown that T cells of AKR mice can stimulate antibody production even in the absence of antigen-specific T cells. They killed CBA T cells with anti θ antiserum together with the complement. The surviving population of CBA/W_1 B cells after transfer did not produce any antibodies when treated with 10μg of antigen DNP-BGG. However, the addition of 10^6 AKR spleen cells to 4×10^6 CBA/W_1 spleen cells treated with anti θ and complement partially restored the production of W_1 antibodies in response to 10μg of DNP-BGG. This indicated that when antigen-specific T cells are replaced by T cells from AKR mice, W_1 cells are antigen-independent and respond equally well to DNP-BGG or DNP-OA.

On the basis of their experimental results, Kreth and Williamson have proposed a model to explain the cooperation between B and T cells. The model takes into account the recent suggestion of Sir McFarlene Burnet that surveillance is the basic role of T cells and they operate by scanning the surface of every cell they come across in the body for abnormal features. Cells with altered antigenic structures (such as certain cancer cells) are recognised as foreign and subsequently destroyed by T cells. Drs. Kreth and Williamson suggest that the

surface scanning role of T cells includes a watch on B cells. According to them, B cells can firmly bind antigens to specific receptors on their surface. Bound antigens will alter the antigenic composition of the B cell membrane, and, hence, will be regarded as foreign by wandering T cells. T cells, instead of killing modified B cells, however, form some link with them and release a factor which provides the stimulus for clonal proliferation. They conclude that the importance of their hypothesis is that it makes it unnecessary to devise two divergent mechanisms for T cell action, one for killing foreign cells and a different one for T cell-B cell cooperation.

Swimming Safer for Asthmatics

SWIMMING is the most suitable sport for asthmatics, say two Australian specialists in physical education, Drs. K. D. Fitch and A. R. Morton of the Human Physical Performance Laboratory of the University of Western Australia. Their recommendation is based on experiments conducted on asthmatic patients in their laboratory. The details are discussed in the *British Medical Journal* (*4*, 577, 4 December 1971).

Asthmatic patients usually suffer difficulties in breathing. These are caused by the narrowing of the bronchi, the air passages in the lungs. Almost all asthmatics develop bronchial obstructions or spasms after exercise, though it is less common for severe attacks of breathlessness to be brought on by exertion.

The Australian scientists studied exercise-induced asthma by comparing the effects of three types of exercise — running, cycling and swimming — in 40 asthmatic patients, aged 10 to 51 years, drawn from local hospitals. A control group of 10 subjects, aged 11 to 39 years, who had no history of asthma or wheezing was also studied. In order to equate the intensity of exertion during the three systems of exercise, a continuous electrical recording of the heart beat was made during each exercise and a constant heart rate was maintained for each subject by speeding or slowing his exercise when necessary.

The influence of exercise on bronchial obstruction was determined by measuring a quantity known as forced expiratory volume (FEV). The recordings were made for two pre-exercise values, six and one minute before exercise, and five post-exercise values, immediately and 5, 10, 20 and 40 minutes after the cessation of exercise. To allow for variations in age, sex and physique when comparing the results of each ventilatory function test, all values for all subjects were expressed as a percentage of the pre-exercise score.

Analysis of data confirmed that normal subjects do not develop post-exercise broncho-constriction. Their response after the three forms of exercise did not differ. Defining exercise-induced asthma as a fall in FEV of at least 25 per cent of the pre-exercise value, it was found that 34 asthmatic patients (85 per cent) developed exercise-induced asthma after at least one of the test procedures. Further, a statistical analysis of the results obtained indicated that exercise-induced asthma occurred after 72·5 per cent of running tests, 65 per cent of cycling tests, but only 35 per cent of swimming tests. Also, in swimming, less severe airways restriction was noted in those who did react with broncho-constriction.

No explanation has been given for the reduction in the intensity of post-swimming broncho-constriction, but possible factors include the horizontal position of the exercise and the effects of hydrostatic pressure. Drs. Fitch and Morton state that swimming has been a favoured exercise prescription of numerous doctors over many years for their patients with asthma, and it is noteworthy that two recent Australian Olympic swimming gold medallists have been asthmatics.

Black Holes versus Neutron Stars

WHAT physical quantities determine whether a dying star will evolve into a neutron star or a black hole? Astronomers believed, on the basis of the work of the Indian-born US astrophysicist, Prof. S. Chandrasekhar, that mass alone was the main factor. They believed that any star more massive than a certain limit (roughly twice our Sun's mass) will collapse into a black hole once its nuclear

fuel is exhausted. With further developments in theories of stellar evolution, however, the importance of the role played by rotation is becoming increasingly clear. Now Dr. Sabatino Sofia of the Department of Astronomy, University of South Florida, Florida, USA, presents calculations in *Nature Physical Science* (*234*, 155, 20 December 1971) showing how rotation affects the last stages of a star's life.

The outer regions of a normal bright star are held by radiation pressure resulting from the heat of the nuclear reactions going on in its core. Once all the nuclear fuel contained in a star is burnt up, it will collapse because of the intense gravitational forces. The collapse will continue until some other force is able to hold up the outer regions once again. If the mass of the star is less than 1·2 times our Sun's mass, the collapse will stop when the nuclei in its centre are pushed closely together. If it is more massive, say less than twice our Sun's mass, the gravitational forces will compress the star still further until the atomic nuclei in the core are broken down into neutrons. These two types of dead stars are now known as white dwarf stars and neutron stars respectively (see SCIENCE TODAY, p. 16, June 1971). But, if the mass of the star exceeds the so-called neutron star limit, even the structure of the neutrons is destroyed by the intense gravitational pressure. The star then continues to collapse to a state in which no light can escape from it — in other words, to a black hole.

According to Dr. Sofia, however, besides mass, the rotational velocity of a star is also a factor to reckon with. He states that the fate of a star depends on the balance between gravitational forces pulling it in and rotational forces pushing it apart. If the rotational velocity of the star is very high, a large amount of matter will be thrown off during the last stages of evolution, as in a supernova explosion, and the remaining core can settle down as a neutron star. If, on the other hand, the rotational velocity is very low, the remaining core will exceed the maximum neutron star mass, and the object becomes a black hole. The interesting question, of course, is just where the dividing line occurs. In the present report, Dr. Sofia has calculated the limiting criterion and applied it to stellar models of masses 5, 7, 10 and 25 times our Sun's mass.

The results of his calculations show that very moderate rotational velocities are enough in all the cases he considered to prevent the formation of a black hole. He finds that for a star with a mass 25 times our Sun's mass, an angular velocity of 4×10^{-6} cm per second is sufficient for stability, and for a star with 5 times our Sun's mass, an angular velocity above $9{\cdot}6 \times 10^{-6}$ cm per second is sufficient. The American astronomer concludes that these limits are unlikely to be more than two or three times smaller than realistic limits. Hence, only very slowly rotating massive stars of the kind often found in binary pairs can evolve into black holes.

It is particularly interesting that there are only two known objects, ε Aurigae and β Lyrae, which are recognised as black holes, and each of these is in a binary system. Dr. Sofia predicts that in case the collapsing star becomes a black hole, because of the slow rotation, its outside will not have the high expansion velocity characteristic of supernova explosions. Instead, a ring of gas and dust will detach from the collapsing object and remain stable by virtue of the high angular momentum of the material. It is more than coincidental that just such rings are postulated to explain the observations of the two suspected black holes.

K. A. Neelakantan

THE MEDICAL WORLD

A New Drug for Manic-Depressive Psychosis

BEFORE the twentieth century very little was known about the pathophysiology of mental and somatic diseases. Medicines like alcohol or opium salts were mostly prescribed on an empirical and physiological basis. These were employed not only to treat the disease but also to make life more bearable. Even today, drug treatment in psychiatry is still primarily empirical because the pathophysiology of mental disorders has not yet been properly determined. Even the knowledge of brain localisation of normal behavioural functions has proceeded only to a limited extent during the last hundred years. Yet the search for suitable pharmacological agents with marked psychological effects has been going on continuously.

Of the various types of mental disorders, manic-depressive psychosis is one of the most common, and its incidence is on the increase, especially in the more sophisticated section of the population. In an editorial in the *British Medical Journal*, 389, 14 August 1971, on " The future of manic-depressives ", it is stated that " an average practice list of 2,000 people contains anything from 20 to 200 manic-depressives who will one day have a serious breakdown. Among these are the people who will at some time kill themselves if the doctor does not treat them when the time comes, for the bulk of successful suicides are manic-depressives ". It is gradually becoming a social and community problem.

Manic-depressive disorders are characterised by alternating periods of mania and depression, but some patients exhibit only one phase which may be either depression or elation. An occasional patient may have only one or two attacks during his lifetime, but periodic recurrences are the rule. Their incidence is greatest among the highest social and professional groups, and twice as great in women as in men.

Many drugs have been found partially effective against certain symptoms or different aspects of mental psychosis. Phenothiazine derivatives and butyrophenones exert a marked quietening effect on excited or hyperactive psychotic patients. Meproborates and other tranquillisers are used in anxiety neurosis conditions. Monoamine oxidase (MAO) inhibitors have been found effective in depression and mania.

Very recently lithium carbonate, a simple salt of an alkali metal, lithium, which is similar to sodium and potassium, has been found to be very effective in small doses in treating patients with manic-depressive psychosis.

The discovery that lithium carbonate (Li_2CO_3) might be effective in the treatment of manic disorders was primarily accidental. J. F. J. Cade first found that lithium carbonate caused sedation in guinea pigs (*Med. J. Aust.* *2*, 349, 1949) and, subsequently, he administered the drug to 10 manic patients with successful results. Later, numerous studies and experiments conducted proved that this drug is superior to phenothiazines in the prevention and control of mental disorders. Psychiatric interest in lithium salts was sustained over the years mainly through the work of Mogens Schou and his colleagues at Aarhus in Denmark. In 1965, Schou and his colleagues claimed that lithium salts were effective not only in the manic phase of the illness but in the depressive phase too. This claim, if validated, would have made lithium a drug of choice for manic-depressive psychosis. But their methodology was the subject of a controversy in the psychiatric world. Later, Johnson and Gershon (*Conprch. Psychiat.*, *9*, 563, 1968) found that 78 per cent of 28 manic patients receiving 1·5 to 2·0 g per day of lithium showed remission of symptoms in an average of eight days. Whereas chlorpromazine causes sluggishness and drowsiness in manic patients, lithium produces a normalisation of effects.

Lithium carbonate is effective primarily in terminating manic episodes in patients with manic-depressive psychosis, typical symptoms of which include motor hyperactivity, reduced need for sleep, flight of ideas, grandiosity, elation, aggressiveness and often hostility. It is also effective as a maintenance therapy in small doses and in some cases as a prophylactic. Unlike other antipsychotic drugs, lithium

(Continued on p. 31)

BLURS & BRIGHT SPOTS

Oh! What a lovely war

EVERYTIME the President of the United States announces another troop withdrawal from Viet Nam, lots of droopy hearts all over the world seem to brighten up. Their hope is based on simple arithmetic: If withdrawal goes on, one day the number of American GIs left in Viet Nam will be zero. Take a breather, dear optimists. The woes of Viet Nam don't owe it all to the American GIs; the bigger cheque comes from technology.

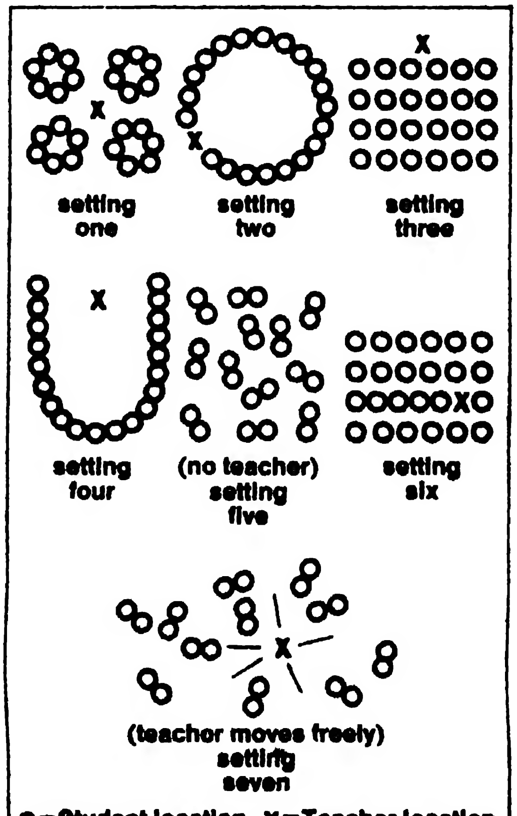
The grim revelation, or rather the reminder, comes from the *New Scientist* which reported on a letter in *Le Monde* (Paris, 15 January) from Professor André Roussel, Deputy Director of the French National Institute of Health and Medical Research. Professor Roussel's rancour arose from a recent international medical conference on the Viet Nam war held in Paris. The participants, both US and Vietnamese doctors who had treated bomb victims, said the bombs dropped daily by the US Air Force — including napalm, magnesium and a combination of phosphorus and aluminium — left wounds " too monstrous to describe". The conventional air-burst bomb which exploded several metres above the ground spewing hundreds of large chunks of steel all around has now been up-dated by plastic missiles which cannot be detected by X-rays and hence make the surgeon's job impossible.

Then there is the " earthquake " or " super " bomb that can clear a forest area big enough for helicopters to land. Few know about the other terrible consequence: the explosion is so tremendous that it dislocates the bone in the inner ear, making adults deaf and children deaf and dumb. Then there is the " booby-trap-bomb ", that parachutes down to send out eight nylon threads, each 8 metres long and apparently invisible but likely to trigger off the explosion at the slightest touch. What has added the grimmest footnote to the anti-personnel bomb inventory is the anti-psyche campaign: psychologists — half-doctors, half-combatants — are being sent out to Viet Nam as " aid men " to conduct psychological warfare, claims Roussel.

Yes, optimists, think again! The President of the United States may have promised the departure of American land forces from Viet Nam. But has he promised the end of misery for the Vietnamese?

You, Sir, did you go to school ?

" *WHAT do you tyke me for, a fool ?* " answered the confident gentleman-of-the-street in Shaw's *Pygmalion* (in the lyricised version, of course!). But, not us. We did go to school. And we have been thinking ever since we saw the item in *Psychology Today*. It said how much you learnt in school depended on how you sat in the class. Around the teacher? Away from the teacher? Remember the sanctum of the last-



O=Student location. X=Teacher location.

bench? Darn the psychologists! As if they have nothing better to do than pose posers.

Like these three psychologists of the Southern Tier Regional Educational Center in Horseheads, New York. What Fred C. Feitler and two fellow researchers did was to arrive one day at Syracuse University's School of Education with a question and a diagram (see page 30) and ask 276 graduates and undergraduates solve the poser.

The poser: which of these classroom seating arrangements would you find the most and least comfortable if you were a student? If you were a teacher?

Can you guess their answers? Here's how it went: The most comfortable position — student-wise or teacher-wise — was setting four. Also settings three and seven were close runners. Which were the least comfortable positions? Invariably, most picked six and one.

The psychologists seemed to agree; they had, in fact, found a theory: The teacher-students relationship is based on a personal need — to be controlled by or to control others. This means the most comfortable seating arrangement must be one that has clearly drawn lines of dominance and dependence. That would explain the rejection of setting six which creates ambivalence for both teacher and students.

Setting five had an interesting catch: it showed no teacher. The psychologists had expected it to be branded in the least-comfortable category. The subjects simply ignored it: a classroom without a teacher was unthinkable. Despite the amount of talk about independent study and individual instruction!

The other surprise was about setting one, which was marked as least comfortable. Here you have students working in small groups with the teacher moving from group to group whenever his help is needed, a method already practised in science laboratory work. But, no, Sir, not very efficient, said the subjects. The most efficient student is one who has the constant and direct assistance of the teacher.

Feitler and his colleagues insist that more such studies are needed. Maybe they will set the schoolroom designers thinking. However, we can't help thinking about the time we went to school. In the traditional classroom setting with the teacher in front of a class in neat rows, we may not have learnt a lot, but — well! that's the point. When we didn't learn a lot, the 'last bench ' was definitely a 'help'.

The Medical World *(Continued from p. 29)*

carbonate does not possess any general sedative properties.

In a paper in *Lancet* (275, 7 August 1971), Alec Coppen and his colleagues elaborated on their studies on the prophylactic effect of lithium on a group of 65 patients. Their study extended over 112 weeks. In this period, patients were randomly given either placebos or lithium and further medication or psychiatric treatment whenever it was necessary. The 28 patients given lithium had a less affective illness and required less medication than the 37 patients in the placebo group. For example, none of the lithium patients needed electro-convulsive therapy whereas 43 per cent of the placebo group received one or more such courses.

Another recent study by Roy Hullin and his associates at High Royds Hospital, Yorkshire, UK (*New Scientist*, 80, 13 January 1972), involved 69 patients treated over a period of five years for depression and for mania. Prophylactic lithium treatment helped bring about a significant improvement in all the patients. For an average period on lithium of 40 months the average frequency of admission per year in the group dropped from 1·09 to 0·18 and the average time spent in hospital from 25·3 to 3·5 weeks. Forty-eight patients had no relapses.

The mechanism of action of lithium carbonate is unknown at present. But work on the effect of lithium on animals and tissues is going on in the Biochemistry Department of the University of Leeds and elsewhere. Work is also going on to ascertain its exact mode of action. In therapeutic doses it is non-toxic but it is safer to use it under medical supervision.

The interesting point in the discovery of this drug is the simplicity of its structure, easiness of its application and universality of its usefulness. Systematic research and clinical trials are being conducted now to ascertain whether lithium carbonate is only effective against manic-depressive psychosis or whether it is the drug of choice for other types of mental disorders also.

Ajoy Gupta

THE ARMS RACE

A suicide that needn't be

The photograph above is almost symbolic. Our choice of it as a motif of the disarmament theme also makes it paradoxical. Because, the photograph was originally used in an advertisement of a US aircraft manufacturer's equipment. This doesn't have to happen, the ad said. We wish it does!

ARMS & MAN

M. A. VELLODI

WE are living in an age of weapons. According to the most conservative estimates, the world is spending over 200 billion dollars annually for military purposes and if this trend continues, annual military expenditures could well reach the level of 300–350 billion dollars (at 1970 prices) by 1980, with a total outlay for the current decade of about 2,650 billion dollars, some 750 billion dollars more than was spent from 1961 to 1970.

This colossal expenditure is highly concentrated in a handful of countries. Of 120 countries with any significant military expenditure, as few as six, namely, France, Federal Republic of Germany, China, UK, USSR and the USA accounted for more than 80 per cent of the world total for the decade of the sixties. The developing countries with almost half the world's population play only a small role in the global arms race, accounting for only about 6 per cent of the world military expenditure. However, the *growth* of military expenditures has been appreciably faster in the developing countries. The reason may be that a number of new states have had to build up their defence forces virtually from nothing. Furthermore, several developing countries have been engaged in local and regional conflicts and in the process they have received substantial assistance from the great powers in money and arms.

The trend to produce and stockpile very large numbers of costly and deadly weapons continues. And, the most fearful class of weapons to which defence spending is devoted are the nuclear weapons. It has been rightly said that in the twenty-five years since the nuclear weapons annihilated two Japanese cities, the destructive power of nuclear weapons has been increased a thousand-fold. Not lagging far behind the nuclear weapons in their awesomeness and destructive power are the chemical

and bacteriological (biological) weapons, the use of which could do as much harm to the user country as to the target country.

Mankind has been aware of these dangers associated with the arms race for quite some time. The United Nations, which exists essentially to assist in the elimination of war, the maintenance of peace and the economic and social advancement of people the world over, has devoted more time and focussed its attention more on disarmament and related matters than on any other single topic. Apart from numerous resolutions relating to disarmament adopted by successive sessions of the General Assembly — a rough estimate would put this at nearly 200 — there have been major studies undertaken by the Secretary-General with the help of experts in the field.

Although the discussions and negotiations at the United Nations and elsewhere have led to some fruitful steps in the field of arms limitation, these have been largely peripheral and have not succeeded in halting, let alone reversing, an arms race which has grown ever more dangerous over the years and ever more wasteful in terms of human and other resources. The figures of military expenditure in 1949 and 1969, calculated at " constant (1960) prices ", ie in ' real resources ' with the factor of inflation eliminated, indicate the world expenditure on preparation of war has trebled in real resources in twenty years. In terms of world Gross National Product (GNP), the present military expenditure of over $200 billion represent something between 6 and 6·5 per cent of the GNP, roughly two and a half times what all governments are spending on health, one and a half times what they spend on education and some thirty times more than the total of all official economic aid granted by the developed to the developing countries. The trebling of world military expenditure between 1949 and 1969 is even more striking and fearsome when we realise that this happened during peace-time in which no two major nations have been at war with each other.

The number of men in the peace-time armed forces of the world increased from 5 million in 1913 to 10 million in 1939, 18·9 million in 1960 and in 1970 the figure stood at 23–24 million. Besides, there are a very large number of persons, estimated in the 1962 UN Report as being over 30 million, engaged in the production of arms and, what is more, most of them are skilled workers. There are therefore well over 50 million people engaged, directly or indirectly, for military purposes throughout the world.

Investment in man

The economic consequences of this ever-spiralling arms race are not difficult to see. The arms race and increased military expenditure absorb resources which are substantial enough to make a considerable difference both in the level of fixed investment and to the volume of resources which can be used for services which are usually treated under the heading " investment in man ", meaning investment in order to increase health, well-being, education, etc. An American publication (*Our Depleted Society* by Seymour Melman, Dell Publishing Co., New York) has illustrated this point as follows:

> " Perhaps we can get a more meaningful view of the cost of defence and overkill if we think of their price in terms of dwelling, schools, and medical-care items. Here are some illustrations:
>
> One TFX airplane, $5,000,000
> = 13 elementary schools, or
> 570 dwelling units in low rent public housing projects, or 278 hospital beds.
>
> One Polaris submarine with 16 missiles, $122,600,000
> = 331 elementary schools, or
> 6,811 hospital beds, or
> 17,723 dwelling units in low rent public housing.
>
> Military space programme (military astronautics and related equipment) 1965 estimate, $1,283,714,000
> = 71,317 hospital beds, or
> 3,469 elementary schools, or
> 143,688 dwelling units in low rent public housing.
>
> Civil Defence budget for fiscal year 1965, $358,000,000
> = 40,071 dwelling units in low rent public housing projects, or
> 967 elementary schools, or
> 249 secondary schools, or
> 19,900 hospital beds, or
> 32,545 nursing home beds, or
> 795 miles of highway in rural areas, or
> 223 miles of highway in urban areas.
>
> Atomic Energy Commission, nuclear weapons programme 1965, $1,800,000,000
> 4,864 elementary schools, or
> 201,477 dwelling units in low rent public housing projects, or
> 100,000 hospital beds.
>
> (Based upon:
> 1 elementary school $370,000
> 1 secondary school $1,433,000
> 1 mile rural road $450,000
> 1 mile city road $1,600,000
> 1 hospital " bed " $18,000
> 1 nursing-home " bed " $11,000
> 1 low rent apartment $8,934) "

Although the above figures relate to the United States, there is no doubt that the conclusion about the 'lost opportunities' would apply equally to all countries engaged in the arms race. It is incontrovertible that the resources which are allocated for military purposes are a reasonably good indication of what is denied to other avenues of public and private expenditure. Military R and D uses up some 25 billion dollars as against 4 billion dollars spent all over the world on medical research. Housing investment, together with slum clearance and urban renewal, represents only about 3–3½ per cent of the world's total national product — almost half of the world military expenditure.

Illusion of spur to progress

It has been claimed that the arms race has given a spur to technological progress, and that we owe to it the development of nuclear power, of computers, of air transport and radar and of electronics in general. But the cost in human lives and the agony and the suffering were far too high a price to pay for them. There is no reason why even more significant technological progress cannot be achieved without war or an arms race.

Ours is a world governed by the balance of power. It has been claimed that this balance of power has brought about a certain sense of stability and the two super powers have not engaged in any direct military conflict for fear of the disastrous consequences. But the balance of power is not a static concept in terms of weapons, both qualitatively and quantitatively. It seeks to keep a balance at very rapidly expanding levels. This is precisely what we mean by the arms race. It means further that many societies become militarised internationally in the sense that the armed forces become an important factor in society even in countries which do not have a full-fledgd military dictatorship. Decisions on major issues of foreign policy are often taken by the military as an exercise in the use of force. The arms race presupposes the inevitability of war because armaments are developed for fighting wars.

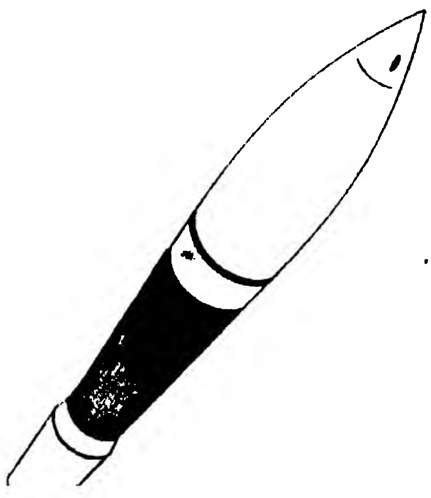
There have been two main attempts to escape from the balance of power and the rule of national force in the world — both made in the wake of 'victories' on the battle-field — the League of Nations and the United Nations which were created, as the Charter of the United Nations states, "to save succeeding generations from the scourge of war". In the new order envisaged in the League and the United Nations, disarmament was given its rightful place and Article 11 of the Charter of the United Nations specifically refers to the contribution which disarmament can make to the maintenance of international peace and security. But the noble intentions did not work out to any practical endeavour.

It was this situation that prompted former UN Secretary-General U Thant to propose in May 1970 that a comprehensive study be undertaken, preferably on an international basis, of the economic and social consequences of the armaments race and of massive military budgets.

U Thant's proposal was taken up by the General Assembly which unanimously adopted a resolution on the need to take vigorous measures "without delay to stop the arms race and make concrete progress towards disarmament, giving the highest priority to nuclear disarmament". Accordingly, the Secretary-General set up a group which comprised experts from Canada, Czechoslovakia, Ethiopia, France, India, Japan, Mexico, Netherlands, Poland, Rumania, UK, USSR, USA and Yugoslavia. The group was a varied one including scientists, economists and diplomats but they had one thing in common, viz, their deep involvement in the problems of disarmament and international peace and security.

Extracts from this unanimous report which was placed before the UN General Assembly last year, appear in the following pages.

[M. A. Vellodi is Joint Secretary to the Department of Atomic Energy, Government of India. He had earlier chaired the experts committee set up by the UN to prepare the report on the effects of the possible use of nuclear weapons (SCIENCE TODAY February 1970).]



DISARMAMENT

The UN Report

THE decade of the 1960s was marked by a greater spread, and by a more extensive technological elaboration of armaments than any by which it was preceded. During the period, there were no developments comparable to the emergence of radio or radar, jet engines or rockets, nuclear weapons or electronic computers. Yet the decade will be remembered because over the ten years which it encompassed, supersonic flight became commonplace, not only in the highly industrialised nations, but also in those countries in relatively early stages of economic development; because of the diversification of nuclear weapons in the armouries of a few major powers, and because their multiplication meant the accumulation of destructive power, only a fraction of which would be enough to eliminate life on earth; because the development of ballistic missiles, and the sophistication of their guidance and control systems, made any point on earth open to precise attack by nuclear warheads; and because space technology added a new dimension to the field of military communications and surveillance. In short, the decade will be remembered because these, as well as other developments too numerous to mention, characterised the arms race of the period.

In 1961, the available data indicated that the world was then spending about $120 billion annually for military purposes, roughly equivalent, at today's values, to $150 billion. Ten years later we find the figure standing at about $200 billion. The trend to produce and accumulate evermore sophisticated and ever greater numbers of costly and deadly weapons continues uninterrupted. More and more States, including a growing number of smaller or developing countries which desperately need to use such resources as they can command for productive social ends, have found themselves impelled along this path.

Nuclear weapons constitute the most fearful category of armaments to which military expenditures are devoted, and these pose the greatest threat which mankind now faces. And, though chemical and bacteriological (biological) weapons have consumed only an insignificant part of total expenditures on arms, the ominous shadow they cast over the world is totally disproportionate to their cost. By far the largest part of the total of military expenditures which is devoted to equipment is, however, consumed in the development, production and purchase of conventional weapons such as aircraft, tanks and guns, the weapons which have been used in the wars which have marred this last decade. This generalisation applies as much to the nuclear powers as to non-nuclear states.

The make-up of military budgets varies from country to country, but it can safely be said that in the major arms-producing countries, on average, about half goes to personnel costs and the rest to a combination of research and development, purchase of equipment, construction, and operations. The estimated total for world military expenditures over the period 1961 to 1970 is 1,870 billion dollars (at 1970 prices) of which it can be reckoned that about 600 billion dollars were devoted to the purchase of equipment. By far the larger proportion of this sum was spent on conventional arms — guns and ammunition, transport vehicles and tanks, communications and surveillance equipment, aircraft and ships. The outlays on nuclear arms which the nuclear powers have made over the years, and which are also included in this sum, have resulted in the stockpiling of weapons with a potential destructive power infinitely greater than that of all other armaments put together. The weapon-systems associated with nuclear armaments are not only extremely costly to produce, but as the 1967 *Report of the Secretary-General on the Effects of the Possible Use of Nuclear Weapons* indicated, their vast 'over-hitting' power makes them, in no conceivable sense a substitute for conventional arms.

Of the total of 1,870 billion dollars which went to military expenditures over the period 1961 to 1970, an estimated ten per cent — somewhat less than 200 billion dollars — was devoted to military research and development. This work was highly concentrated in the six countries — the United States, the Soviet Union, the People's Republic of China, France, the United Kingdom and the Federal Republic of Germany — which now account for more than four-fifths of total military expenditure. Although only a minor part of the total, it is this outlay for research and development which determines the main features of the modern arms race — the qualitative changes in armaments.

On the surface it would seem that the effort to improve the quality of armaments, or to defend against them, follows a logical series of steps in which a new weapon or weapon-system is devised, then a counter-weapon to neutralise the new weapon, and then a counter-counter-weapon. But these steps neither usually nor necessarily occur in a rational time-sequence. The people who design improvements in weapons are themselves the ones who as a rule envisage the further steps they feel should be taken. They do not wait for a potential enemy to react before they react against their own creations.

Technological developments

Vast technological developments have occurred in weapons and weapon-systems designed for air, land and sea warfare. The development and deployment of supersonic aircraft, equipped with air-to-air weapons, has greatly increased the cost and complexity of what are still regarded as conventional fighter aircraft. A modern fighter-bomber costs ten times the aircraft of ten years ago which it replaced, while a sophisticated interceptor aircraft today could cost more than 10 million dollars, compared with 150,000 dollars for the corresponding aircraft of World War II. The vulnerability of such expensive weapons to attack when deployed on airfields, as well as that of their fixed bases, have in turn encouraged the production of vertical take-off aircraft and of the armed helicopter. These developments have widened the range of aircraft in service and the scale of the aeronautical research which has been called upon to support their development.

The familiar chain of new weapon, counter-weapon and counter-counter-weapon has also characterised the sphere of land warfare. The dependence of armies on armoured vehicles has intensified, the response to this change being the continued elaboration of sophisticated anti-tank weapons. Helicopters have been brought into greater use, in the effort to increase the mobility of land forces, particularly for the conduct of military operations in areas where communications are poor. This, again, has increased the ' depth of capitalisation ' of the armed forces, that is to say, the ratio of equipment costs to total military expenditure. But here, too, a counter-measure has appeared in the shape of the one-man anti-aircraft missile.

In the naval sphere, nuclear and gas turbine population have added new dimensions to the design of ships' machinery, at the same time as the armament systems of a ship have become a much more important element in its cost. The increasing vulnerability of surface vessels to air attack has been countered by the development and installation of anti-aircraft missiles. Counter-measures have followed, such as the stand-off bomb, which can be launched from beyond the range of the shipborne missile, and the ship-to-ship guided missile.

Stocks of armaments

National inventories of stocks of armaments are never published, but some figures are available which reflect these various qualitative changes. At the outset of the decade, hardly any intercontinental ballistic missiles (ICBMs) had yet been deployed. By the end of the decade the estimated members were 2,150. In 1960 the deployment of submarine-launched ballistic missiles was negligible. By the end of the decade, some 55 nuclear-missile submarines were operational, comprising about 800 missiles, capable of delivering about 1,800 warheads.

From 1960 to 1968 the world stock of fighting vessels is estimated to have increased from 4,550 to 4,900. This relatively small increase in numbers masks the much larger increase in the value of this stock (at 1968 prices); the value of the stock in 1960 was about $34 billion, as compared with $60 billion in 1968, a 75 per cent rise.

A much more striking change occurred over the period in the world stock of supersonic fighters. At the opening of the decade their

Why do nations go to war? This is how the mechanism works: To remain in the Arms Race, big nations must produce a lot of arms. To keep on producing, the stock must be sold. The stock goes to smaller nations. Then conditions are created for them to go to war with neighbours. The stock gets used up and must be replaced. The wheel comes full circle

estimated number was 6,000. By the end it had doubled. In 1960 there were 15 production programmes for supersonic aircraft; by 1970 these too had doubled.

The scale of the economic burden resulting from the arms race, and which the picture drawn in the preceding paras reflect, can be readily appreciated, even if some of the figures may lack precision. As already noted, military expenditures for the world as a whole added up to an estimated total of 1,870 billion dollars (at 1970 values) over the last decade. Annual expenditures have increased by more than 50 billion dollars to reach their present level of about 200 billion dollars, between 6 and 6·5 per cent of the total of World Gross National Product (see Table 1). **Military expenditures are in fact now running at two and a half times what all governments are spending on health, one and a half times what they spend on education, and thirty times more than the total of all official economic aid granted by developed to developing countries.** The economic scale of current world military expenditures can be realised even more dramatically when one remembers that they all but equal the combined GNP of the United Kingdom and Italy, or that of the developing countries of South Asia, the Far East, and Africa together, with a total population of 1,300 million people.

An increase without reason

In a period in which no major nations have been at all-out war with each other, it is a new departure for the world to devote so large a proportion of its resources to military uses. Compared with previous periods in which the more highly industrialised countries were not at war with each other, such as the years before the First World War of 1914–18, or the early nineteen thirties before the Second World War, there have been two major changes. First, the world's standing armies are much larger than they used to be. Second and more important, the qualitative changes in weaponry with which these armies are equipped have grown immensely in lethal power, in cost, and in complexity. Up to now the 'second industrial revolution' — for example, the commercial and technological exploitation of computers and electronics — has probably had a much more powerful impact on the military than on the civil sector. In consequence, the relative share of world output devoted to military uses in the years since 1949 has been at least double what it was in 1913, when there had already been three years of competitive re-arming between the great powers. It then stood somewhere between 3 and 3–1/2 per cent of world GNP. From 1950 to 1970, in the period following the Second World War, the share of world output going to military uses has been about 7 per cent. In short, if we compare the period after the Second World War with that before the First, world military expenditure has risen about twice as fast as world output.

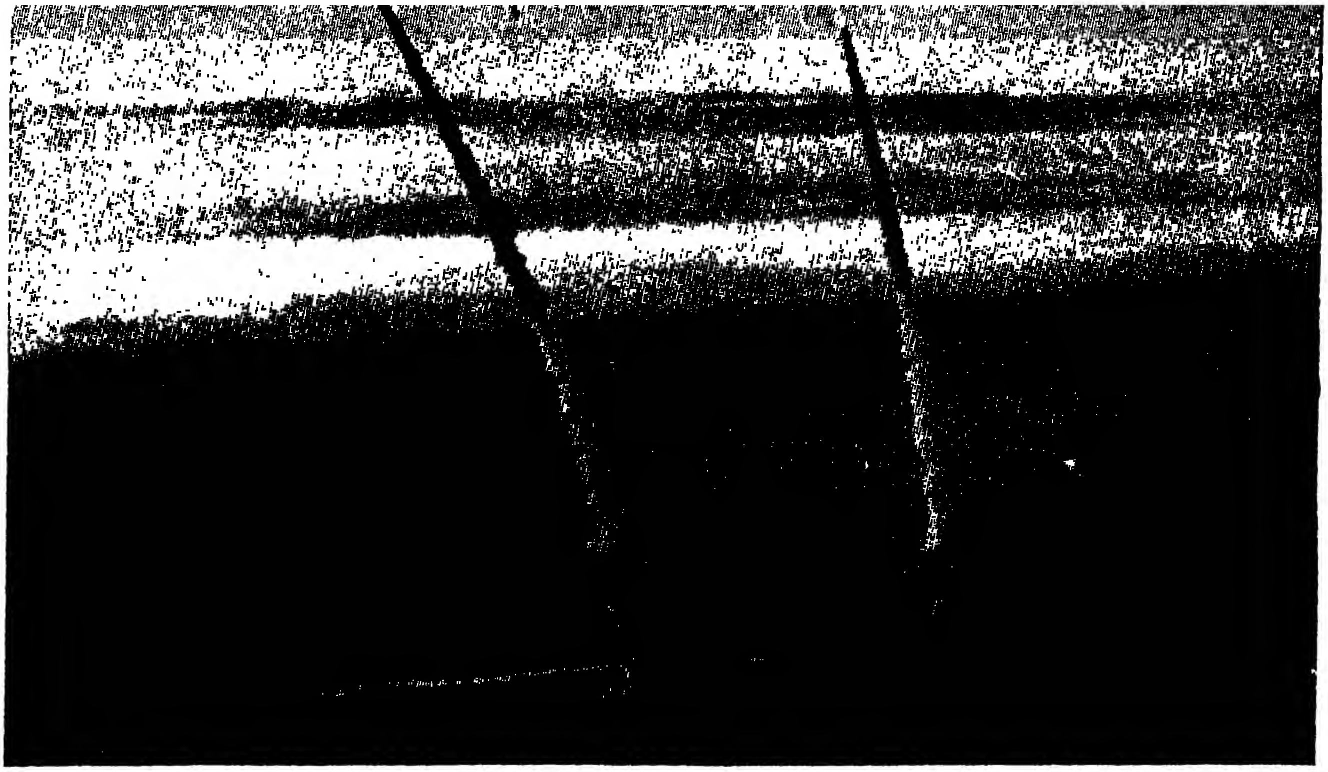
Over the past twenty years, the rise, though rapid, has been irregular. It has tended to go up sharply in periods of crisis or war, and then level off for a number of years, but without returning to the pre-crisis figure. Thus, in the short space of the three years between 1949 and

Table 1. World Military Expenditures and GNP: 1960-1970
(Amounts in billions of constant 1970 dollars)

Year	World Military Expenditures	World GNP	Military Expenditures as per cent of GNP
1960	150·5	2,023·5	7·4
1961	156·1	2,116·6	7·4
1962	167·6	2,213·7	7·6
1963	174·2	2,313·7	7·5
1964	174·0	2,462·4	7·1
1965	174·9	2,589·8	6·8
1966	190·5	2,732·0	7·0
1967	206·5	2,842·8	7·3
1968	209·9	2,963·9	7·1
1969	209·6	3,096·0	6·8
1970	202·6	3,204·1	6·3

The 'brotherhood-of-man' game: hold hands and dance with the piper. But remember, 'the dance of death' can be played the same way

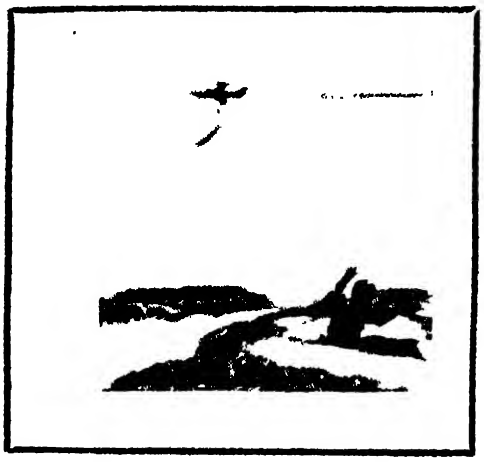
"Dance of death". Last image from Ingmar Bergman's Seventh Seal



Two US Minuteman ICBMs being launched in salvo from Vandenberg Air Force Base in California

1952, world military expenditure doubled in real terms. It then remained approximately level for nine years. It rose to a new plateau in the early sixties, and then very substantially from 1965 to 1967. It then levelled off.

World military expenditure is highly concentrated in a few large countries. Six countries out of 120 alone accounted for more than four-fifths of the world total for the decade of the sixties. These countries dominate, and indeed largely determine, the world trend. Not only do they account, in parallel with their relatively enormous contribution to world GNP, for the bulk of military expenditure. For a variety of reasons, partly historical, partly political, they also devote to military spending a larger proportion of their resources — about 8 per cent of their output, as an average — than do most other countries.



Developing countries play a lesser role in the global arms race. With nearly half of the world's population, they account for only about 6 per cent of world military spending. Further, they devote a smaller share of their resources to military purposes — only about 3-1/2 per cent of their total national output goes to their armed forces. (Averages for the group of developing countries as a whole are, however, misleading. At the top end of the scale, some nine developing countries devote more than 10 per cent of their output to military purposes. At the lower end, there are eleven countries for which the figure is less than 1 per cent.)

Although military spending in developing countries is very low in relation to that of the advanced countries, it is significant that in the decade of the sixties the rate of growth of military expenditures was appreciably faster in the developing countries than the world average — some 7 per cent a year against a world rise of about 3 to 4 per cent.

This rapid rate of increase should, however,

be interpreted with caution. The arms race in the ' third world ' can be directly related to the wars in which it has been engaged. But as is fully recognised, some conflicts have not been conducted independently of the great powers, who have provided considerable supplies of weapons and of finance. In other regions military expenditures have been rising from a very low base. A number of new states have been building up their armed forces virtually from nothing. When stated in terms of percentages, the rates of increase in these countries will obviously appear very high.

Another measure — manpower

It has been estimated that about 50 million people — more than the whole working population of, say, the United Kingdom and the Federal Republic of Germany — are engaged directly or indirectly for military purposes throughout the world. The available information does not permit a more precise figure. Fairly accurate figures for the armed forces alone are available, but they are not a good substitute for expenditure estimates — partly because the armed forces have become increasingly capital-intensive. Not only is the ratio of equipment costs to total expenditure rising, but in a number of countries the armed forces have been employing an increasing number of civilians to do work which was previously done by servicemen.

It is worth noting, however, that the figure for the personnel in the world's armed forces as a whole reached a total of 23-24 million by 1970, and that it had been rising at a rate of about 2 per cent a year during the decade of the sixties. Very little of this rise occurred in the six major powers, whose increase in military spending can be accounted for mainly by the elaboration of the weapons they produced or bought. Virtually all of the increase in military manpower occurred in the developing countries, whose share of the overall total for the world's armed forces is now about 37 per cent, in contrast to a 6 per cent share in military expenditure. Over the past decade the numbers in their armed forces have been rising by 4 per cent a year.

The basic reason for the momentum of the arms race is very simple. Countries usually try to keep their military forces up to date and to improve their arsenals of weapons. The soldier does not wish to be outnumbered or " outgunned " by a potential enemy, or potentially out-manoeuvred because of his greater mobility, or neutralised by his better defences. This applies as much to the developing countries which import their weapons, as it does to the most powerful industrial nations which develop and manufacture them.

It is the latter — not the former — who are the pace-setters of the arms race. They again are the ones who, partly as a result of the development of technology for military purposes during the Second World War and the succeeding ' cold war ', have also had a considerable impact on the development of science-based industries in the civil field which are complementary to those which provide military material, for example, aircraft. The military technologist is urged relentlessly to work at the frontiers of applied scientific knowledge, and to incorporate in the design of new weapons or weapon systems the most advanced engineering techniques.

The arms race of the major powers is now a competition to achieve an advantage not just in quantity but even more in quality — in the

The Russian ICBM — SS 9

speed of aircraft, the range and accuracy of ballistic missiles, in the manoeuvrability of tanks, in the efficiency of radar systems, and so on. The arms race has in fact become essentially a technological race, the achievements of one side spurring the other to improve on the technological advances which itself might have made. Sometimes the spur comes not from some clearly defined threat but from an imagined technical advance made by the other side. Secrecy in military affairs makes it inevitable that a potential enemy will usually be suspected of being stronger than he actually is. Consequently both sides strive continuously to improve the quantity and quality of their arms. So it is that the arms race becomes based on the "hypothesis of the worst case", that is to say one of two sides designs its programme of development on the assumption that its rival could, if it so decided, be the stronger.

Whatever their nature, and however much they interact, the alternatives which have to be sacrificed in order to maintain a military establishment can for convenience be classified under the general headings of the goals of immediate consumption, whether private or public, and those which serve the purpose of future economic growth. It is the former category which is in general epitomised in the well-known catchword "the choice is between guns and butter".

Poverty and slums exist even in the richest countries. Housing is still an unsatisfied demand; in every country, including the richer ones, its improvement calls for an immense amount of investment both in urban and rural areas. Housing investment, together with slums clearance and urban renewal, represents only about 3 to 3½ per cent of the world's total national product, although if one considers all "housing services" the percentage is somewhat higher. But in the world as a whole far fewer resources were devoted to new housing during the sixties than to military expenditures. This is particularly true of the major countries.

Pin-point bombing in Viet Nam with the help of laser beams directed from the ground

Health services, like education, constitute a major demand which is less than adequately satisfied, even in the richest countries; and in the poorer countries, with high death-rates from preventable diseases, with large numbers suffering from chronic sickness, and with high infant mortality, there is a crying need for more resources. For the world as a whole, military expenditure is about two and a half times the estimated total of publicly-financed health expenditure. A rough calculation suggests that all medical research in the world consumes only about $4 billion. This compares with some $25 billion spent on military research and development.

Benefits for developing countries

Many developing countries do not have an industrial sector capable of arms production, and so import most of their arms from abroad. A reduction in their arms spending would produce savings and, therefore, free foreign exchange resources which could be used for the import of more investment goods, thus facilitating a higher rate of growth.

The effects of military expenditure on the economy are not limited to the diversion of resources from other uses. Military expenditures also tend to disturb and destabilise the course of the economy in general, particularly when they fluctuate sharply. The size of defence appropriations is decided primarily on political and military grounds, and military expenditures do not easily accommodate to changes in the economic situation of a country. The rest of the economy has only too often had to be adjusted, to fit in with military exigencies and with the time-cycle of military developments.

In terms of balance of payments, it is usually the developing countries which stand to lose most from their military expenditures. The reasons are not far to seek. As weapons become more sophisticated and more expensive to develop, fewer countries are able to produce them; for, as is becoming increasingly obvious,

advanced military technology is now the prerogative of the powerful industrialised countries. If therefore a developing country wishes to acquire sophisticated weapons and if none of the countries manufacturing them wishes to provide them by way of military aid, the developing country could incur a considerable balance of payments cost in acquiring either the weapons or the background technology (or both). The credits from the arms trade go to countries with highly developed defence industries; the debits go to countries without them.

Against the long catalogue of harmful effects of the arms race and military expenditure, one benefit which has been claimed is the spur given to technological progress. Obviously, if there is such a benefit, if war is the mother of invention, the cost in human lives and misery has been far too high a price to pay for it.

Social consequences

Against the background of the Second World War, the fear engendered by the nuclear arms race was one of the factors which stimulated the post-war disillusion of the youth in many countries, whatever the level of their military spending. Every child learned that he lived in a world in which violence had become commonplace, and which was now stocked with sufficient lethal power to wipe out all human life. This awareness has undoubtedly helped to create a psychological background of uncertainty, of fear and anxiety, and sometimes of social rejection or disillusion.

The arms race also tends to change traditional relationships between the civilian and military sectors of the economy. The military sector means more than the military forces themselves. It includes the firms and industries which serve them, the scientific institutions where their research is done, and the political establishments and ministries that owe their power to the arms race -- a combination which has come to be called the 'military-industrial complex'. Fear of a potential enemy leads a country to set up a military establishment, and this establishment in turn acts to keep the fear alive. It will suspect and question the sincerity of any conciliatory moves from the other side, and in general act to preserve a political image of the world as one which will always require a high state of military preparedness. That is a further social consequence of the arms race.

●●

What's Fair in Warfare

"ALL's fair in love and war," they used to say, but in war some holds are certainly barred, not so much by international law as by convention. Certain weapons are tacitly eschewed by warring nations, not because they are evil but because their use will confer no decisive benefit on the user or will bring retribution.

The existence of agreements and conventions, however, need be no bar to the use of prohibited weapons. In the last century, 25 nations including France, Germany, Russia and Austria-Hungary signed a convention against the use of poison or poison arms, particularly gases, but this did not prevent some of them from employing gas warfare in World War I.

In World War I the French were the first to use teargas in trench raids, and the Germans retaliated. A year later the Germans launched a full-scale attack with chlorine gas released from thousands of cylinders. The British made their first gas attack five months later.

In all such cases the victim of the attack does not possess the weapon, but the advantage of the attacker is neutralised when the victim too acquires the weapon. Hitler's last "secret weapon" in World War II was Tabun nerve gas, but he refrained from using it during the Normandy invasion because he was afraid of Allied gas strikes. Gas in warfare also

has the serious drawback that a change in wind direction can send it in the direction of the using side.

Even if nuclear weapons are not used, there is a whole arsenal of new and little-publicised weapons — mostly chemical and bacteriological — evolved or perfected since the last War.

Chemical weapons

Chemical weapons belong to several categories. There are the *toxics* — gases or drugs which produce casualties when ingested or inhaled or when they come into contact with the skin. *Choking* gases act on the respiratory passages and lungs and include chlorine, which was used in World War I.

Nerve gases are systemic poisons developed by the Germans during World War II, and are the most lethal of the lot. They poison vital nerve junctions by preventing the enzyme cholinesterase from destroying acetylcholine, a normal transmitter of nerve impulses. Acetylcholine then accumulates in the motor nerve endings to such an extent as to paralyse the voluntary muscles as well as the central nervous system.

Blister gas is best known in the form of mustard gas, which was widely used in World War I. Burns of the eyes, skin and the respiratory system are produced. At room temperatures mustard gas evaporates so slowly and odourlessly that victims don't realise for hours that they were exposed to it. It injures all human tissue surfaces with which it comes into contact, inflames the eyes, blisters and burns the skin, and attacks the nose, throat and lungs. Nevertheless, it is classified as a non-lethal gas. Militarily, it seems to be on the way out, because it takes hours to produce casualties.

Blood gases like hydrogen cyanide interfere with the utilisation of oxygen by the body tissues. *Incapacitants* have been much discussed in recent years. These are supposed to render a person mentally incapable of functioning for a long time, after which he recovers without ill effects. The best known of these is LSD (lysergic acid diethylamide), which produces visual and other perceptual disarrangements, plus disorders in thinking. The response to such chemicals is however extremely variable and usually short-lived.

Chemical weapons may be used to soften a strongly defended enemy position, to contaminate wooded areas to prevent occupation by the enemy and to contaminate damaged transport facilities to prevent their repair. Casualties can be caused with minimum damage to vital installations.

What are the conditions under which chemical warfare is likely to be effective? Military leaders have to weigh the consequences of a mass attack with chemical weapons, eg the effects might spill over borders and harm friendly countries. Also, in comparison with nuclear warfare, its scope is limited and its use appears to be more tactical than strategic; it would not be possible to score a quick and easy victory with presently available chemical weapons.

Biological warfare

Military planners have never been very keen on biological weapons. True, they have certain advantages, eg they are cheap to produce, they are self-propagating in the human host, they are easy to deliver; and only the human population would be affected — roads, bridges and buildings would be left unharmed (for this reason biological warfare has been euphemistically described as "non-destructive warfare").

An ideal BW agent would be one for which no treatment exists, and against which only the user possesses a vaccine. Such a disease is probably unknown. Mumps, for instance, is not likely to be used, because though it is highly infective, it is not severely incapacitating, and the vaccine is mass-produced. Anthrax would be a highly suitable BW agent because the spore-forming version of the organism, which causes the disease, can live in the soil for years, but it would represent a hazard to invading troops of the user country.

Biological agents could be used tactically for specific restricted action. The attack might consist of placement of infectious agents in the water or milk supplies or air-conditioning systems of factories There is no easy detection of such tactics especially because of the minute quantities used. Strategic use of BW agents involves their distribution over large areas (as aerosols — finely divided dust or liquid sprays — from aircraft) to affect humans, animals or grain fields in such a way as to impair a nation's capacity to wage war.

The most effective BW agents would be those that incapacitate for a longer time and cause a greater drain on the community's facilities. In general, all agents must produce the illness well before the development of the host's defence mechanism (antibodies) — a process usually taking one to two weeks. Also the agent must be easily prepared and suitable for storage in large quantities.

It has been found with certain BW agents that their effectiveness increases as the dried particles are made smaller. This is particularly true of agents which enter the host by way of the lungs. At about 1 micron size (0·00004 inch) these agents as aerosols pass by the natural barriers in the human nasal passages and lodge in the very small air sacs in the lung. When the dispersed particles are larger, they may settle down like dust before reaching the host.

There is no knowing what will be the result of using a BW agent in actual warfare, because the transmission of disease in nature is complicated and ill understood. The agent of the rabbit disease myxomatosis, when introduced deliberately into wild rabbits in Australia in 1950, failed in the beginning. Then suddenly it broke out 32 kilometres

away, and spread rapidly throughout Australia. Only later it was discovered that two types of mosquitoes were involved in the spread.

Sound gun

It is quite possible that even nuclear weapons will become obsolete one day, as technology advances. For instance, the French have invented a gun that fires infra-sound, against which there is no defence. Infra-sound is sound so deep that it extends far beyond the range of human hearing and transforms itself into shock waves which can not only destroy buildings but also wrack havoc inside the human body. Low-intensity infra-sound acts on the internal parts of the ear, producing all the symptoms associated with sea-sickness; medium-intensity infra-sound can cause paralysis and coma. And high intensity infra-sound acting on the heart and circulatory system can bring about death.

The War against Vegetation in Viet Nam

Among the novel weapons employed in the Viet Nam war are herbicides, which have been sprayed over forests and cropland to deny resource and cover to the Viet Cong. One of the factors contributing to the phasing out of the programme, which has wrought havoc with forest and cropland, has been the pressure mounted by the scientific community against it. Here ARTHUR H. WESTING, Professor of Botany, Windham College, Putney (Vermont), who went to Viet Nam on behalf of the Scientists' Institute for Public Information and *Environment* magazine, reports on the effects of the anti-plant programme

THE US aerial anti-plant spray programme in South Viet Nam has recently been phased out with as little fanfare as it was phased in some nine and a-half years ago.

" Ranch Hand ", the military herbicide programme, has always had two distinctly separate missions. Its major effort, accounting for almost 90 per cent of all aircraft sorties, has been directed against the forests of South Viet Nam in an attempt to deny cover and sanctuary to the other side. The remaining effort has been directed against rice and other crops as an important component of the US resource denial programme.

Over the years, the US has sprayed South Viet Nam with more than 72·3 million litres of concentrated herbicides formulations, covering 2·1 million hectares, or fully 12 per cent of the total area of South Viet Nam. (There have also been limited clandestine military spraying in Cambodia, Laos, and North Viet Nam.) The chemical formulations used were restricted for the most part to agents " Orange " (2, 4-D, and 2, 4, 5-T), "White" (2, 4-D, 1/5 picloram), and " Blue " (the sodium salt of dimethyl arsenic acid) (see Table 1). " Orange " and " White " have been the preferred agents against forests, " Blue " against crops.

As the secret herbicide programme slowly became known during the mid 1960s, the scientific community mounted a major campaign whose main thrusts were to obtain information on its details and scope, to assess its impact on the public health, ecology and sociology of Viet Nam, and — as the adverse effects became apparent — to put an end to it. Several independent investigations were conducted, the last one being in August 1971 by F. W. Pfeiffer and myself.

Dubious success

The tactical success of the herbicide programme " Mission Ranch Hand " has been dubious; its frequent incidental damage to trees (timber, rubber, and fruit) as well as to crops in inhabited non-target locations has been a continuing source of major aggravation; its real and assumed effects on the health of humans and livestock have struck fear into countless civilians; its long range damage to

the environment has been of serious concern to scientists in South-East Asia and throughout the world; and its debilitation of the forest resource has been drastic.

To me the most callous aspect of the programme has been the intentional destruction of crops. Over the years this has resulted in largescale food deprivation — to friend and foe alike — to a poverty-stricken civilian population already suffering from widespread malnutrition and disease.

The herbicidal damage to South Viet Nam has been of monumental proportions. In those upland forests that have been subjected to one spraying, an estimated 1·4 million hectares, a minimum of 10 per cent of the overstory trees, and often two or three times that fraction, have been killed. In the multiple-sprayed upland forests, estimated at 0·4 million hectares, at least half and sometimes all of the trees have been killed. Some of the herbicide-killed trees, perhaps as much as 10 per cent, have been salvaged for lumber, but most are rotting in place.

Particularly in the multiple-sprayed upland forest areas, ecological debilitation has been severe. These areas are not coming back to trees. All told, an estimated 32 per cent of South Viet Nam's 5·5 million hectares of dense upland forests have been sprayed one

A laboratory of death

Viet Nam has become a vast laboratory for the testing of new weapons by the United States which evidently believes that advanced weapons and techniques could make it possible to conduct limited warfare with a saving in American lives and with a substantial advantage over a less technically developed adversary.

One of the weapons most used in Viet Nam is napalm. A napalm bomb consists of petrol or kerosene with a slower burning petroleum jelly base. Its effects on survivors are worse than the immediate casualties: they die a lingering death, or if they recover, are permanently disabled. Napalm is sometimes preferred to the conventional bomb because it can be dropped at very low altitudes — less than 15 metres — without risking damage to the aircraft from shock waves.

A new type of anti-personnel bomb used is the "cluster bomb" which dispenses several hundred bomblets over a wide area, each bomblet in turn throwing out shrapnel like a large hand grenade. The area that is filled with flying pellets reaches out several hundred metres. Soldiers lying in trenches are relatively secure, but civilians running for cover have little chance of escape.

Jungle-eating

The defoliation programme has now reached a low level and has now been "Vietnamised". A new

Table 1. Major herbicides sprayed by US in South Viet Nam (based on US Department of Defence data)

Agent	Composition	Active Ingredients	Application Rates (per hectare)	Dosage (per hectare)
"Orange"	A 1 : 1 mixture of the *N*-butyl esters of 2, 4-dichlorophenoxyacetic acid (2, 4-D) and 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T).	491 and 527 gm/litre, respectively	Undiluted at 28 litres	14 and 15 kilograms, respectively
"White"	A 4 : 1 mixture of the tri-*iso*-propanolamine salts of 2, 4-dichlorophenoxyacetic acid (2, 4-D) and 4-amino-3, 5, 6-trichloropicolinic acid (picloram) in water.	240 and 65 gm/litre, respectively	Undiluted at 28 litres	7 and 2 kilograms, respectively
"Blue"	A 6 : 1 mixture of sodium dimethyl arsenate and dimethyl arsenic (Cacodylic) acid in water.	371 gm/litre	Undiluted at 28 litres	10 kilograms

programme has been replacing it since 1965, reaching major proportions from 1968 onwards. It is the "jungle-eating programme", the chief agency of which is the US Engineer Command. Its basic tool is the 20-ton D-7E Caterpillar tractor fitted with a massive 3·5 m wide " Rome " plough blade equipped with a special 1 m lance or " stinger ", and with 14 tons of armour. These outfits bulldoze continuously from dawn to dusk, seven days a week. No tree appears to be too large and no jungle too dense to escape these powerful machines in what must certainly be the most intense land-clearing programme in history.

The plough blades skim the surface of the ground, each tractor scraping bare almost 0·4 hectare an hour. Most trees are simply pushed over, but the really large ones are split by the stinger. In operation, the tractors move in a long staggered formation, the lead tractor being directed for much of the time by the company commander circling overhead in a small helicopter.

By mid-1967 these tractors were organised in small units. Virtually all major roads in South Viet Nam have been cleared for 100 to 200 metres on either side. In some instances, chemical herbicide treatment has helped to maintain these strips in a treeless condition.

Superbomb

One of the most awesome and least publicised weapons used by the Americans in the Viet Nam war is the BLU-82/B general-purpose high-concussion bomb. Otherwise known as the 'Daisy Cutter', this bomb pales the 5,000 kg 'block-buster' of World War II by several shades.

The Daisy Cutter is of record dimensions. It is 1·5 m in diameter, over 3·5 m long and weighs 7,000 kg. Within its thin steel case are 6,000 kg of a special, dense blasting agent (DBA — 22M) consisting of a gelled aqueous slurry of ammonium nitrate and aluminium powder.

This superbomb, whose concussive blast is surpassed only by that of a nuclear bomb, is floated to the ground by parachute from 2,300 to 3,000 m but the point of impact is seldom more than 100 m off target. The bomb is detonated by an impact fuse at the end of an attached one-metre probe which sets off the main charge simultaneously at both ends of the bomb just above the ground. The resulting radial blast blows away all trees or such obstacles to create a clearing about a hectare in area. The blast is so powerful that aircraft 3·5 km away are shaken by the shockwave. The clearing produced by the explosion can be used immediately as a landing zone by assault helicopters.

The lethal zone for each bomb has a radius of about 1,000 metres (or 300 hectares area). In the innermost circle of a hectare even the worms in the ground are killed. Beyond this circle of death, concussion injury spreads in diminishing fashion radially for a distance of about another 550 metres. The Daisy Cutter has been in use in Viet Nam for several months now.

---

or more times. An estimated 0·1—0·2 million hectares of the coastal mangrove forests have now been sprayed one or more times, representing about 25 per cent of the total 0·5 million hectares once occupied by this lowland forest type. For as yet obscure reasons, even one spraying totally annihilates the mangrove type, leaving it completely desolate for an extended period, measurable in years and possibly in decades. The significant fraction of destroyed mangrove is likely to have an adverse effect on the offshore and river fish and crustaceans that depend upon this habitat for breeding and/or nursery grounds. We heard several anecdotal accounts from Vietnamese fishermen that tend to support this assumption.

Crop destruction

US crop destruction missions have affected about 0·3 million hectares, concentrated to a considerable extent in the traditionally food-poor Central Highlands, regions populated to a significant extent by primitive hill tribes (Montagnards). The usual target for aerial herbicide destruction has been upland rice, a conservative yield estimate for which is 560 kg of milled rice per hectare per year. Thus the total estimated destruction via this aspect of the US resource denial programme, for the years 1962–1970, comes to over 163 million kg of milled rice. Since a Vietnamese can presumably survive on 180 kg of milled rice per year, the amount of food destroyed by this means is the equivalent of more than 894,000 total annual diets. The morally and legally inexcusable aspect of this programme is that between 90 and 99 per cent of the denied food was destined for civilians. This fact was fully known to the US Government; in fact, my information comes from Government studies completed in 1967 and 1968.

We flew over several valleys in the mountains of Quang Tin and Quang Ngai provinces in which the crop lands had been sprayed (with Agent " Blue ") in late 1969 and/or mid-1970.

At least from a vertical distance of roughly 500 metres, these areas seemed to have recovered more or less completely. In a number of instances they were back in cultivation (by the "enemy", according to our US military guide, but more likely by intrepid Montagnards).

Medical problems

We received a number of seemingly authentic reports from farmers and woodsmen, having firsthand spray experience at the receiving end, of mild temporary ailments (including dizziness, headaches, vomiting, diarrhoea, lacrimation, coughing, and dyspnoea). Poultry mortality was again reported, as was temporary illness in larger livestock (including fasciculation). Some of the reports can perhaps be attributed to confusion with the effects of the antipersonnel gas "CS" (ortho-chlorobenzalmalononitrile) used in large quantities in Indo-China, and others perhaps to confusion with possible malathion (S-(1,2-dicarbethoxyethyl)-0,0-dimethyldithiophosphate) poisoning, used in large quantities in the malaria control programme. Perhaps the 1·5 million kg of elemental arsenic that has been dropped on agricultural lands via the Agent "Blue" has contributed to the problem.

As is now widely known, the Agent "Orange" contained a highly toxic and teratogenic (foetus-deforming) impurity known as dioxin (2, 3, 7, 8,-tetra-chlorodibenzo-para-dioxin). Whether or not the significantly increased incidence of birth defects (eg, pure cleft palate and spina bifida) among Vietnamese infants in recent years can be attributed to dioxin exposure has not yet been established. But the spectre of perhaps as much as 550 kg of dioxin (assuming an average 2, 4, 5-T contamination level of 25 parts per million) introduced into the environment — and thus to the food chains — of South Viet Nam is most disquieting.

The "phase down" of the chemical spray programme can be attributed to a number of factors, among them: the general winding down of US ground involvement in the war; the clear tactical superiority of the "Rome" plough landclearing programme; and last but not least, public pressure from the scientific community.

The herbicide programme today continues entirely under the jurisdiction of the South Vietnamese armed forces. From what we could gather from US military and Embassy sources, the operations appear to be on a relatively small scale, and presently use only Agents "White" and "Blue".

In conclusion, it is my hope that both the US and South Viet Nam rely on the good legal and moral judgment of the 82 or more other members of the world community of nations by following their lead in condemning the use of herbicides as weapons of war, and that Indo-china provide the last chapter in the infamous employment of such a potentially valuable class of materials.

In wild west style . . .

The extermination of the bison in the American West has found its modern counterpart in the massive defoliation, crop destruction, bombing and ploughing programmes carried out in Viet Nam, according to Dr. E. W. Pfeiffer, a University of Montana zoologist. He visited Viet Nam several times to study the effects of new weapons systems on the environment.

Dr. Pfeiffer has made a study in depth of the ecological devastation caused by the conventional high explosive bomb: the US has dropped in Indo-China more than twice the tonnage of bombs that was dropped on Europe, Asia and Africa during World War II. He estimates that Indo-China's landscape has been permanently rearranged by more than 20 million bomb craters; using an estimated average diameter of 10 metres, this means that the craters alone would cover a combined area of about 130,000 hectares.

Farmers are unwilling to cultivate fields which have been bombed, shelled or mined, partly because the craters are water-filled and partly because of the danger from unexploded munitions. Subsistence farmers who had made their living off the land so attacked have had to move either into refugee camps or into the cities.

Dr. Pfeiffer sees an underlying purpose in the "ecocide" practised by the US armed forces in Viet Nam. He finds an apt parallel in the ecocide of the American West, which included the slaughter of the bison which figured largely in the economy of the Redskins. This policy was designed to bring the latter to their knees, and it did.

• The Disarmament Game

A FORTUNATE paradox of the arms race is that though the developed countries happen to be the biggest spenders on war, they try to keep out of direct embroilment. They have even taken certain steps from time to time to check the arms race and to eschew certain forms of warfare. The Partial Test Ban Treaty, the Treaty on Outer Space and the Nuclear Non-Proliferation Treaty are generally cited as proof of the nations' concern at the arms race, although these agreements have done no more than nibble at the disarmament problem. Many pessimists view these talks as attempts at buying time, until something infinitely superior comes out of the super-powers' test-laboratories. Even now the super-powers are running a missile race.

What is tragic about the colossal expenditure on arms -- even from a military standpoint -- is that much of it is wasteful, because the over-kill power now at the disposal of the major military powers is fantastic Nuclear stockpiles now amount to 50,000 megatons -- enough to blast every person in the world with the equivalent of 15 tons of TNT or about 60 tons per person in the NATO and Warsaw Pact countries taken together.

For members only

Since the conclusion of the Partial Test Ban Treaty, the superpowers have made use of the Disarmament Committee to prevent any poaching on their nuclear preserves. They have deployed their diplomacy to get the signatures of the small fry on the Nuclear Non-Proliferation Treaty (NPT) which was signed in 1968.

The rationale of the NPT is that when more children play with fire, the chances of a conflagration are greater. The NPT provides *inter alia* that (1) non-nuclear nations will not produce nuclear weapons; (2) the nuclear powers will abstain from increasing their stockpiles of nuclear weapons; (3) in the case of nuclear aggression, the UN and the Security Council will intervene and give protection to the non-nuclear weapon nation party to the Treaty.

It is obvious that the NPT is hardly a model of equity. Only 47 nations have ratified it so far, and it will have no binding force till France and China as well as emerging nuclear nations sign it, eg Egypt may feel threatened when Israel goes nuclear.

India is among those nations which have not signed on the dotted line. This leaves her with the option of making nuclear weapons, though her declared policy is to use nuclear energy for peaceful purposes only. The Indian stand all along has been that the nuclear arms race is central to the problem of disarmament, that proliferation covers nuclear weapons, too, and that non-proliferation is out of the question so long as the superpowers are allowed to multiply their weapons and as long as existing stockpiles are not destroyed.

The balance of terror

One criticism that has been levelled against measures like the NPT is that they seek to limit the arms race to those already in the running. Just now the US and the Soviet Union seem to be locked in a fresh struggle for nuclear supremacy.

The development of missiles that can span continents in minutes has for some years been a nightmare to military planners of the super-powers, particularly because of their ability to attack with no warning whatever. Though in the early sixties the Soviet Union was way behind the US in missile production, by 1965 it had succeeded in closing the missile gap. The concept of deterrence or restraint began to develop from the near parity maintained between the two powers. In sum, it means that a surprise attack by A could cause colossal damage to B, but B would still have the power to hit back (the "second strike" capability). Since the first strike is aimed at the enemy's weapons, any system which prevented his offensive capability from being wiped out completely would give him an edge.

To penetrate what was thought to be a heavy Soviet ballistic missile defence system, the United States undertook the construction of multiple independently targeted re-entry vehicles (MIRVs), in which each missile carries several warheads, each of which goes to its target with an accuracy equal to, if not greater than, that of the original warhead. If such a missile were used as a first-strike weapon, it would give an unbeatable advantage to the power which struck first.

The Johnson Administration's plan to construct an ABM system to protect the major American cities was given up in view of the huge outlay involved. Instead it was decided to deploy a 'thin' ABM system to protect the Minuteman missiles, the chief component of America's strategic system. Ostensibly, the 'thin' ABM system was a defence against China's growing nuclear prowess.

Advocates of the ABM system argued that the system would have a stabilising influence between the superpowers and save millions of lives in the event of a nuclear war. It was also described as a bargaining counter in the coming talks for limiting strategic arms (SALT) at Helsinki between the two powers. Opponents of the ABM said that it would contravene the intent of the NPT at a time when Moscow seemed anxious to curb the arms race.

The coming of MIRVs and ABMs has increased the need for earnest efforts to control nuclear weapons. It has also complicated the SALT talks which have been going on for the last two years. Inspection has been the most troublesome question in arms control discussions.

To determine whether the Soviets have deployed their own MIRVs requires inspection of the payload, because except at close quarters, an MIRVed vehicle is indistinguishable from a conventional vehicle. And the Soviets object strenuously to any thorough inspection.

Both sides have now realised that there would be no winner in a fullscale nuclear war. Each has the capacity to destroy about half the population of the other in a first strike. This *Pax Nucleara* between them is the result of a rough parity in a mutual assured destruction capacity. At present, the major categories of offsensive weapons on both sides are fixed, land-based ICBMs, submarine-launched ballistic missiles (SLBMs) and long-range bombers, of which both sides have almost equal numbers. The Soviet Union however has a slight lead in megatonnage (1 megaton = 1 million tons of TNT) and the US leads in SLBMs and bombers. In the matter of surprise, too, which would be crucial in a nuclear war, neither side has an advantage. This is because there are too many strike weapons which are too widely dispersed and too secure to be destroyed en masse.

This strategic balance would be upset by new technological developments. If the Russians go in for MIRVs, the Americans would feel that their deterrent (the land-based missiles) would be imperilled, and would proceed to strengthen their ABM system. As even this would not provide 100 per cent invulnerability, they might replace the land-based systems with the more expensive submarine-launched missiles. Currently, the US is modifying some of its Polaris-missile submarines to fire the Poseidon missile, which is planned to carry 10 or more MIRVs.

Going the whole hog

No substantive reduction in arms has taken place, despite all the arms control talks and treaties. Strictly speaking, the Partial Test Ban Treaty, The Outer Space Treaty and the NPT are not disarmament measures. They merely sanctify the *status quo* or prohibit an unlikely action. The NPT provides no real security guarantee for non-nuclear weapon states which have perforce to rely on military alliances centred on one of the major nuclear powers.

The Disarmament Committee, now known as the Conference of the Committee on Disarmament (CCD), was set up in 1961 by the UN General Assembly to serve as a forum for disarmament negotiations. The major treaties on arms control have, however, been concluded in forums other than the CCD. In fact, the final negotiations for the Partial Test Ban were conducted in tripartite talks at Moscow, not Geneva. The co-chairmen of the CCD are the US and the Soviet Union and many off-the-record negotiations occur under the rubric of a meeting of the co-chairmen. At times decisions have been taken over the heads of the eight non-aligned states but these latter have helped to break the frequent impasses in the negotiations. The committee is also weakened by its boycott by France and China.

On the credit of the CCD's ledger can be put the draft treaty for banning biological weapons for ever. Incidentally this was the first time since the disarmament talks began in 1962 that the NATO and Warsaw Pact countries joined in sponsoring a disarmament convention. Since the USA has been using chemicals like defoliants on a large scale in Viet Nam, chemical weapons were not included in the draft, though at the wishes of the neutral nations the treaty was firmly linked to future negotiations on similar banning of chemical weapons. However, banning biological weapons is not a great sacrifice, since they constitute only 10 per cent of the US arsenal. — **P. K.**

LOOKING BACK . . .

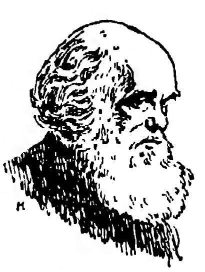
COPERNICUS (19 Feb 1473) : If the 15th century saw the birth of the scientific revolution, it was the Polish astronomer, Niklas Copernic, better known as Nicolas Copernicus, who fathered it. He founded the heliocentric theory of the universe with the Sun at the centre and the planets revolving around it. (Till then, the Earth was thought to be the centre of the universe.)

"Though trained in canon law to manage ecclesiastical affairs, which he did quite conscientiously for practically the whole of his life, and in fields like medicine, finance and pol'.ics, Copernicus was primarily concerned with a new theory to explain the universe since his student days in Italy. He presented the theory in his book, *De Revolutionibus Orbium Coelestium* (On the Revolutions of the Heavenly Bodies), the publication of which he deliberately delayed to avoid the wrath of the Church. It was published in 1530, literally in the last days of his life; the first copy reached him only a few hours before he died. The Church, however, condemned his theory.

According to the Copernican theoty, the Earth has three kinds of motion: a daily rotation or spin on its own axis making day and night, an annual orbit around the Sun and a gyration of the Earth's axis to account for the precession of the equinoxes. Since these motions follow mathematical laws, one can predict the position of any planet at any particular time. And even the occurrence of eclipses can be told in advance. The theory was a fundamental departure from Ptolemy's 1400-year-old system of geocentrism and the religious notions bestowing a special status on the Earth and a privileged position for those who inhabited it. This meant freedom of science from theology. It also laid the foundation for modern astronomy and a new approach to natural phenomena based on accurate observation, analysis and experimentation to be followed later by Brahe, Galileo, Kepler, Newton, etc. Rightly, it was called the Copernican Revolution. Copernicus died on 24 May 1543.

DARWIN (12 Feb 1809) : Though formally trained in medicine and churchmanship, Charles Darwin was interested in the study of nature as a whole, beginning from the most primitive and simplest forms of life to the most developed. The geological studies of Charles Lyell and those on population growth by Malthus had excited him. A five-year round-the-world voyage became his proving ground. In the course of his voyage he had collected a vast variety of specimens of rocks, fossils, birds and plants and had also recorded his observations of all kinds of variations, characteristics, peculiarities and the circumstances that made them so.

His concept of evolution (better known as Darwinism) is a theory of historical development of the organic world which said that variations in the members of the same species are quite evident and empirical facts. Observing the tendency of organisms to increase geometrically while members of another species remain stable, he concluded that there is a struggle for survival and only those survive who have the most favourable variations, some of which are transmitted to the offspring. And here is the most basic and important feature of Darwinism — the factor of natural selection or the survival of the fittest, not necessarily the strongest. If an organism is not fit to live in certain surroundings, it fails to adapt and is ultimately eliminated. Darwin's concept of natural selection, however, was only an observation. The analytical part of the job was done by Mendelian genetics.



In spite of not being a scientist in the usual technical sense, Darwin's influence on the scientific world has been unique. He wrote profusely. In the *Origin of Species by Means of Natural Selection or Preservation of Favoured Races in the Struggle for Life* (1859) he set forth the basic propositions of the theory of evolution. In the *Variations of Animals and Plants Under Domestication* (1868), he did pioneering work in genetics by trying to solve the problem of how the variations came about. *Descent of Man and Selection in Relation to Sex* (1871) applied the rules of natural selection to anthropology, and *The Expression of the Emotions in Man and Animals* (1872) took his theory to psychology. He died on 19 April 1882.

VOLTA (18 Feb 1745) : Of all 18th century scientific studies, electricity commanded the maximum attention. But most studies were concerned with static electricity. It was left to the Italian physicist, Alessandro Volta, to delve into the field of electric currents. His most celebrated invention was the electric batteries, known as " Voltaic Piles ". His name is also retained in our measure of an electric unit, the volt, for the strength of such batteries.

Historically, studies in current electricity began with Luigi Galvani (1737-98) who was working on electric shock — the effects of electricity upon living creatures (observed in organisms when placed in contact with two different kinds of metals). Volta also conducted a variety of experiments to locate the source of this electric current. Ultimately, he demonstrated that the disturbance was a physical electrical phenomenon caused by the contact between different metals themselves and not (as Galvani thought) by the organisms which were merely sensitive detectors of electricity produced by the contact of those metals. He built a stack or pile of copper and zinc plates arranged alternately and separated in pairs by blotting paper or flannel moistened with acid to serve as electrolyte. Current from this pile produced the same effects on living creatures.

This was immediately followed by his discovery of the Voltaic Cell, in which electricity was created by the chemical action of a metal dissolving in an acid.

However, in the earlier years when he was a 30-year-old school teacher, he had invented and perfected the electrophorus, a device for producing electric charge by induction. His other inventions include the condensing electroscope — an instrument used to detect and measure electricity in water vapour and smoke. He also studied atmospheric electricity and the composition of marsh gas. He died on 5 March 1827.

GALILEO (15 Feb 1564) : The Italian astronomer and physicist, Galileo Galilei, took the scientific investigation of natural phenomena beyond where Copernicus had left it. He mathematically formulated many physical laws and developed the concept of acceleration as the rate of change of velocity per unit time and that of friction and inertia as applied to objects in motion. In fact, many of his conclusions foreshadowed Newton's Laws of Motion.

Galileo had originally started by examining Aristotlian theories through mathematics and experimental observations. This ultimately got him involved in the study of motion and mechanics, and heavenly bodies too. And even while he was studying medicine in the University of Pisa, he made his first important discovery that the rate of swing of a simple pendulum depends only on its length; he designed a pendulum of variable length for measuring the pulse rate of patients. By simple demonstrations of simultaneously dropping bodies of different weights from the Leaning Tower of Pisa, he proved that bodies fall with velocities that increase regularly with the time of falling. This disproved Aristotle's theory that the speed of falling bodies was proportionate to their weights.

Galileo was interested in the stars and had designed for himself many telescopes. He discovered that the Moon shines with reflected light and that its surface is mountainous, the Milky Way is made up of innumerable stars and the Sun has spots which move across its surface. All these observations firmly confirmed the Copernican theory.

He wrote several books, among them *Letters on the Solar Spots, Messenger of Stars, Dialogue Concerning the Two Principal Systems of the World* and *Dialogues Concerning Two New Sciences.* He was brought to trial twice and persecuted by the Inquisition for his heretical views. He died on 8 January 1642.

MENDELEYEV (7 Feb 1834) : Although Dalton had greatly emphasised the importance of atomic weights in the earlier part of the 19th century, the real cornerstone of chemical theory was laid by the Russian scientist, Dmitry Ivanovich Mendeleyev, in 1869 when he discovered the basic relationships of all chemical elements.

Mendeleyev's chief contribution was to the development of chemical atomism and to the practical application of the law of transition (quantity to quality) to the chemical elements. Mendeleyev's Law said that the properties of the elements varied in a periodic manner with their atomic weights, and a periodic table of the elements was drawn up to illustrate the law. However, the arrangement in the table had some gaps. Mendeleyev then took the bold step of predicting that these gaps were in correspondence with the elements not discovered till then, and also their properties and weights. His predictions proved to be accurate when they were vindicated by subsequent discoveries. The family of elements now known as the rare gases of the atmosphere, however, escaped his scheme because of some discrepancies in his table which were later corrected by Moseley in his New Periodic Law in the second decade of the current century. Mendeleyev died on 2 February 1907.

BRAIN TEASERS

The mixed-up boat race

Four friends got together one day. Each possessed a motor boat so they decided to have four races. But they made one condition: each one of them would use a different boat for each race.

In the first race Ram used Shyam's boat. In the second Shyam took Pathak's boat. David won the third race in his own boat " Vijaya ". He won the other races too. Pathak sailed in " Sarasa " for the second race. Ram used " Sarasa " in the fourth race and he came second after "Arrow " in this race. The fourth boat was " Bullet ". Who owned " Bullet " ?

Who sat where?

It always happens after parties. People discuss them for days. Well, Radha and her five friends got down to discussing the party of the day before. It had been Radha's birthday party. And they came down to the seating arrangements. Each tried to recollect in what order they were seated around the table.

Radha recollected that Jaya was sitting at her right. And Jaya felt Maya was on her right. Asha said Leela was to her left while Maya felt she was to the right of Radha. But Sheela was confident that she was sitting to the left of Asha.

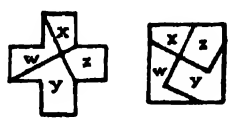
Two of these girls were wrong in recollecting their positions. Could you work out the correct seating arrangements ?

S. Balakrishnan

(*Solutions next month*)

Solution to last month's Brain Teasers

1.



2. 22 moves are needed i e: C, E, S, A, R, C, E, S, A, R, C, E, S, L, M, B, E, S, L, M, B, L.

Child-poisons in the house

Is there any reason why your child should gulp down a mouthful of drain cleaner? Or liquid soap? Or furniture polish? Or his father's medicines? Except that children are curious? And you are careless? And the containers look like irresistible toys?

THERE are literally dozens of ways in which children can hurt or kill themselves, such as getting knocked down by a car, touching a live wire or eating contaminated foodstuff. But perhaps such mishaps are easier to guard against than the less obvious dangers that lurk in the house — detergents, liquid furniture polishes, polythene films, etc which can harm children when accidentally ingested.

Most of these come in beautifully printed containers. And most carry no cautionary labelling. The attractive get-up of the container entices you. You feel like stretching out your hand and touching it. For children, naturally, the colourful look is irresistible. What's more, a compound that may do little or no harm to an adult can do irreparable damage to the tender tissues of a child, because toxicity also depends on the ratio of the poison weight to body weight.

In the US, 1 to 2 million children swallow harmful substances every year. Very young children tend to swallow cleaning materials and other non-food products, while children aged 4 to 5 tend to ingest medicines. The statistics for India are not available. Most child-poisoning cases, unless they are extremely acute, are treated by local practitioners. They are not reported unless fatalities occur. However, it is safe to presume that a sufficiently large number of children do suffer from accidental poisoning from household products. Is there a way to prevent it?

Containers and labels are generally designed to sell the product and not to keep them out of the hands of children. Nor do manufacturers take care to use ingredients that will do the least possible harm to children when accidentally ingested. For instance, manufacturers by preference use petroleum-based liquid polishes, though less lethal substitutes are available, and yet nothing has been done to ban them. Dishwasher detergents use highly caustic ingredients and there have been cases where children who have swallowed these compounds have got painfully blistered.

Of course, it should be remembered that the vast majority of household products is non-toxic in small amounts. Cosmetics are harmless unless large amounts are taken. Soaps may cause vomiting; liquid shampoos are harmless, but dry shampoos may contain toxic substances like carbon tetrachloride, isopropyl and methyl alcohol. Toothpaste is harmless, so are black and blue inks, but green and purple inks contain anilene dyes that are harmful in large amounts. Chalk is harmless, so is the graphite of lead pencils, but coloured pigment in large amounts is dangerous.

The fact that in a household it is not possible to isolate harmful products completely beyond the reach of children makes some kind of supervision in their manufacture and sale imperative on the part of governmental agencies. In the US, the Harmful Substances Act arms the government with the power to prescribe labelling requirements for public health and safety. It can even order a product off the market when it finds that no amount of cautionary labelling will reduce the health hazards. The

A checklist of baby-poisons

Of all the household products toddlers can put into their mouths, the vast majority are not toxic. The peril lies more in the undue panic created and the hazardous, high-speed ride to the hospital emergency room.

To allay fears, Dr. Howard C. Mofenson of Mineola, Long Island, N.Y., president of the American Association of Poison Control Centers, lists many of the ingested items that need not cause parents anxiety:

Toiletries and laundering agents – **Cosmetic preparations are relatively safe unless large amounts are taken. Baby cosmetics are completely safe. Soaps may cause vomiting. Bubble bath soap has little toxicity. Detergents for laundry are safe. So are liquid household detergents. However, electric dish washer detergents can damage the throat, stomach and respiratory tissues. Liquid shampoos are not harmful but dry shampoos may contain carbon tetrachloride, isopropyl and methyl alcohol, which are very toxic. Most deodorants are safe but suntan preparations containing alcohol and organic solvents can lead to intoxication. Large amounts of stannous fluoride in toothpaste are not harmful if swallowed by a child.**

Tobacco and matches – **Nicotine is potentially very harmful but is not easily ingested. The vomiting that frequently occurs is protective. A year-old child could consume 20 books of safety matches before the chemicals in the match head would produce toxicity.**

Writing materials – **Black and blue inks are safe but green and purple inks contain aniline dyes that are hazardous in large amounts. Ball-point pens do not have enough ink in the cartridge to be of concern. Lead pencils have non-toxic graphite, but coloured pigments in large amounts are dangerous. Red and orange crayons are the only harmful colours if they do not contain the letters AP, CF or CS 130-46. White or coloured chalk is safe.**

Medicines – **Mercurochrome and merthiolate are not well absorbed and rarely produce toxic effects. Candy laxatives are relatively safe but may produce catharsis lasting up to three days. Vitamins and the " Pill " are non-toxic. Saccharin may produce loose stools but no toxicity. Single tablets of most any medication won't harm.**

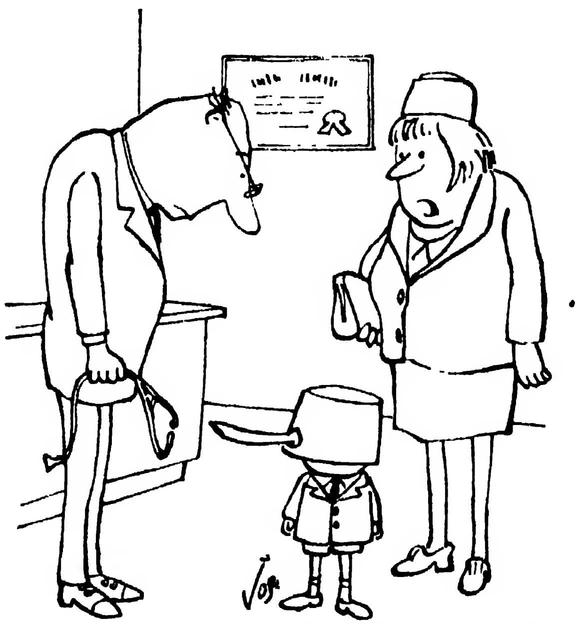
Miscellaneous—**Outdoor paints have large amounts of lead. Teething rings and bathtub floating toys contain water, glycerin and mineral oil, which are safe. Most adhesives, fish bowl foods, modelling clays, putty, shaving creams and paraffin candles usually are not harmful.**

While the foregoing agents are not harmful, their accessibility should serve as a warning that inadequate supervision exists in the household. This should be corrected, Dr. Mofenson warns, before a tragic toxic ingestion occurs.

Act, however, has been used sparingly. Even companies manufacturing furniture polish which causes severe illness on consumption by children have been allowed to go scot-free; one or two agreed to re-formulate their products to reduce their toxicity while others did just nothing.

The next best thing to banning hazardous products is to enforce child-resistant packaging. Last year, the Poison Prevention Packaging Act was passed, which empowered the US government to establish standards for packaging any household product or drug to protect children from injury. Child-resistant containers cost little and have shown their efficacy in reducing child-poisoning. Studies have shown that a " Palm- 'N - Turn " cap, which has to be pushed down while unscrewing, was so effective that none of the children who tried could open it even after having been shown how. Such containers also have an educational effect, reminding an adult, each time a child-resistant container is opened, of the ever-present threat to children. Curiously enough, pharmacists and drug manufacturers have failed to make voluntary use of such child-resistant containers.

Of course, the snag with child-proof containers is that parents sometimes fail to re-cap them after use. Which is why they are less than 100 per cent effective.



" Mind you don't break the vase underneath "

THE INSECT WORLD

BEES

SUMATI K. SAMPEMANE

NATURE usually leaves the sweet and beautiful well-protected. The rose has its thorns. The honey bee has its stings. The sting hurts. But you needn't worry about killing the bee. It will die anyway. It is suicidal for a bee to part with its stinging barbs.

A bee injects about 0·003 gm of venom in a sting, enough to kill its lesser animal and insect foes. But there is one species, the wild honey bee (*Apis dorsata*), that can kill a man. Not singly, of course, but in a horde. The venom is secreted from two pairs of glands. (One secretion is acidic, the other alkaline. But neither in itself is very potent.)

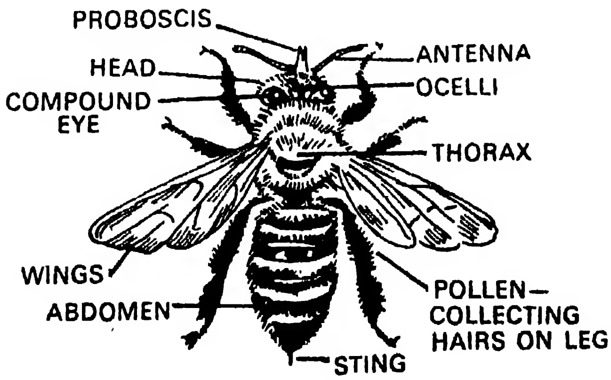
The sting is a modification of the egg-laying organ, the ovipositor. That means only the females have it. The sting consists of a pair of barbed lancets. These proceed with alternate thrusts into the puncture even after they have been separated from the bee's body. The backward-curved barbs give a firm hold on the flesh. But they cannot be withdrawn. The bee tugs hard and eventually may manage to break away from the barb. But in the process it suffers considerable muscular damage, enough to kill it.

The odour of the venom attracts the other bees. They are aroused and attack the invader en masse. And bees do use their suicidal stings to protect their pot of gold — the honey-filled comb. But strangely, the venom has certain pharmacological uses — as a cure for rheumatism and neuralgia—so much so that bees are specially raised for their venom in pharma apiaries.

They come out on warm sunny days, flitting from flower to flower, looking for nectar and pollen for the immediate and future needs of their colony. But the nectar the bees collect is too thin and prone to fermentation if stored for long periods. So they concentrate it and carry it back to their home in their honey crop, a compartment of the alimentary canal. Once home, they regurgitate the nectar and expose it over and over again on their tongues till it reaches just the right consistency by evaporation. They are joined by the fanning bees who keep fanning out the damp air — in the manner of exhaust fans.

During evaporation, the nectar is mixed with certain enzymes. The final product, the honey, has a little bit of salt, vitamins, proteins, traces of several acids and a lot of sugar (80 per cent). This honey is a real health-giver. It is easily absorbed by the body and has a higher caloric value than either rice or cream. If you ask the centenarians, many of them would credit their longevity to the 'golden food'. Ask the mod, beauty-conscious women and they would stand by honey as an aid to complexion, a slimming formula and many other things.

Bees produce more honey than they actually need. The excess is deposited for the future. And the bank keeps growing. Scout bees go out on exploration trips. Generally, bees have a well-developed sense of sight and smell for guidance. It has been found that a bee can see over a colour range about equal to that of human vision. But with a slight difference: the bee's colour range is shifted slightly to the violet side. This means it cannot see red, confusing it with black and dark greys, but it can clearly see ultraviolet which is beyond the human vision. Bees cannot distinguish between green, yellow and orange. They also confuse blue with purple and violet. Whereas man can discern about 60 different shades of colour, a bee can see just four—yellow, blue-green, blue and ultraviolet. Certain whites that absorb ultraviolet appear blue-green to them. Purplish-red appears blue. (Red flowers are bird- and butterfly-



The form, structure and vital parts of a bee (worker)

pollinated. But those that reflect ultraviolet light get pollinated by bees too.)

Fragrance is another lure. Once a scout alights on a flower, it literally wallows in it. Its hairy body picks up a lot of pollen which is mixed with the nectar to a paste. This is carried home in the pollen basket — a hairy enclosure at the base of the hind leg.

Once home, the foraging bee wastes no time in telling the others where to find more. The method of communication is unique. The home-coming bee goes into a gyrating dance; the others watch intently, every now and then feeling the body of the forager with their feelers to acquaint themselves with any scent there might be. If the source is close by the scent is sure to linger on.

There are two types of dances. The round dance indicates a supply of food within 50 metres, but it doesn't indicate the direction of the supply. The wag dance, on the other hand, indicates precisely where and how far the food source is. It is generally used when the source is over 100 metres away. The in-between distances are indicated by an intermediate type — the sickle dance.

In the wag dance, the dancer walks in a straight line, wagging its abdomen vigorously to shake off any perfume that might still cling to its body. It then veers 360° to the left. It goes back to the straight line only to turn right this time. The number of turns in a given time tells the distance, and the direction of the straight line indicates the direction of the food source.

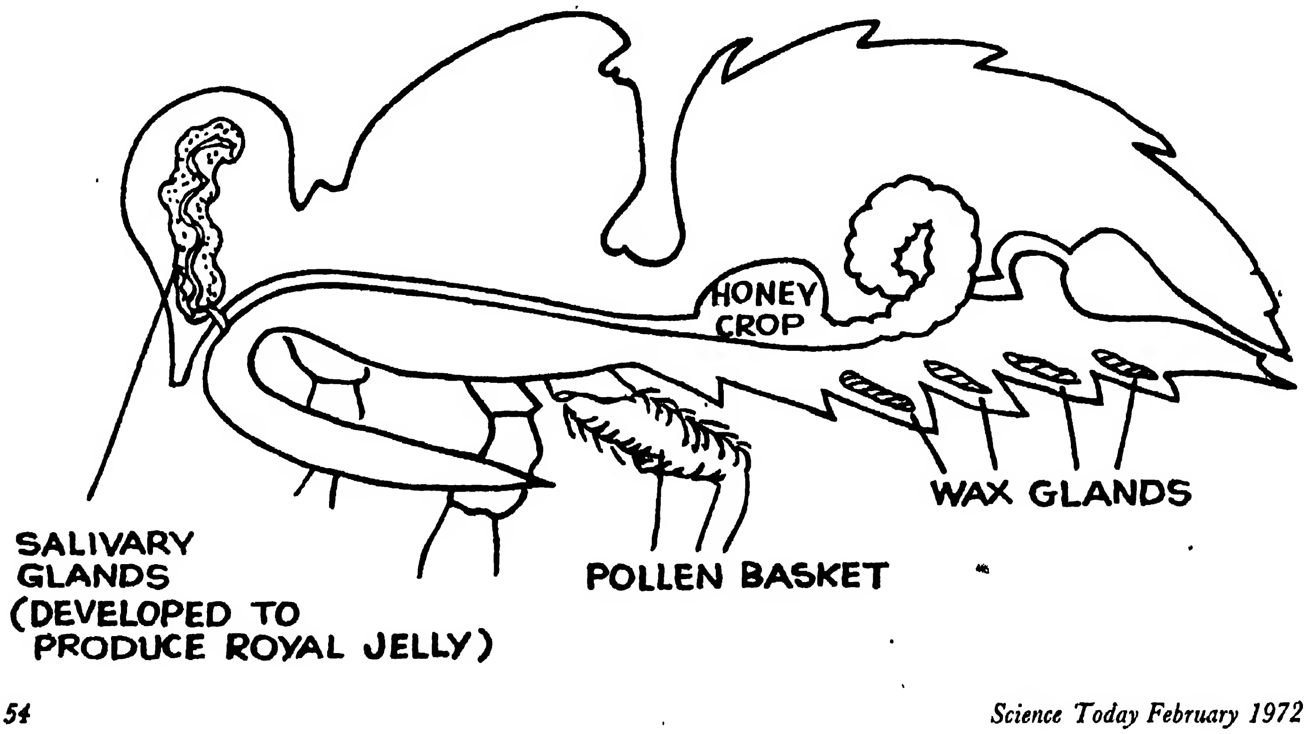
Bees can judge direction by the position of the Sun in relation to the polarised light reflected from the sky. As time passes, the direction of the straight line rotates, showing that it is oriented to the position of the Sun. Even on dark, overcast days, a patch of blue sky is sufficient for a bee to orient itself with the position of the Sun and thereby know its directions.

This may explain one strange aspect in a bee's sense of direction. Though it might have followed a roundabout path to a food site, when it comes to telling the others the way, it gives them a bee-line to the site — even if it has never personally travelled over this straight route. This is made possible through an analysis of the polarised light

If a source of food has no identifying scent, a bee is not deterred. It opens its scent glands and deposits its own odour on the source. This helps others that come later to identify the source — a sort of " this way please " sign.

Bees choose to stick to a particular type of flower as long as the supply is plentiful. This is because a bee has to learn to manipulate each

Bees cannot yield royal jelly or wax all their life. During the early days of adult life the salivary glands are enlarged for jelly production. When this work is over, the salivary glands come back to normal size. The wax glands begin to operate. The bee then becomes a breadwinner



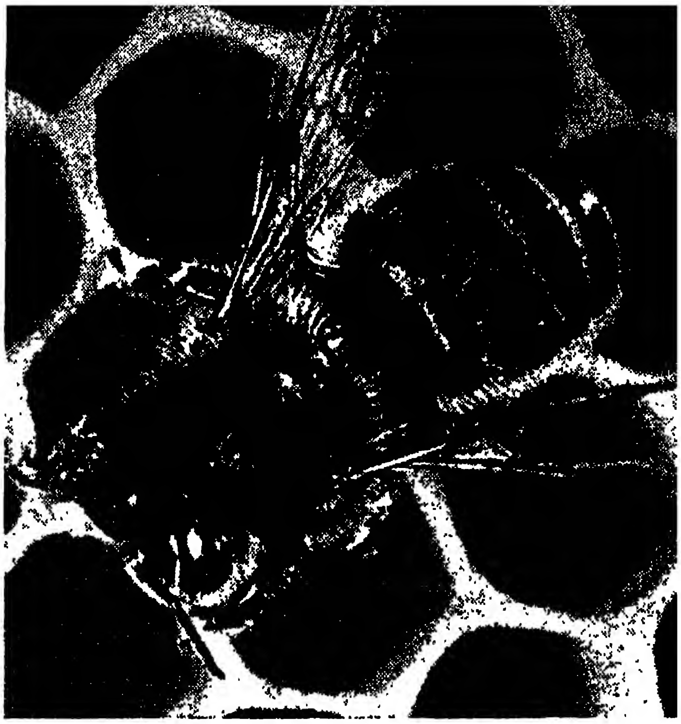
flower in a different way. That is why foragers following a scout may completely ignore other brilliantly coloured and profusely scented flowers on the way. This peculiarity helps nature's plans for cross-pollination by keeping the bee flying from flower to flower of the same species.

The females are the driving force in a hive. Ungallant, lazy drones are thrown out into the cold whenever there isn't enough food to go around. The queen bee rules unchallenged. The drone has but one function — to mate and inseminate. Yet only a small percentage of drones fulfil their mission. Like the sting of the female, the mating spell of the male is suicidal — it cannot tear itself away from the queen without suffering mortal injury.

The well-knit community of the honey bee (*Apis mellifera*) consists of a queen, its host of industrious but sterile worker-daughters and the good-for-nothing, wastrel drone-sons. The queen maintains law and order not by logic or authority but by secreting a chemical from the top of its head. The workers lick the chemical and transfer it to the whole population in the hive in the process of feeding one another. This substance is particularly important to the workers. When supplies fall either due to the death, illness or old age of the queen or due to over-population in the hive, the workers set about building royal nurseries for the future queen.

The young are brought up in hexagonal cells which also serve as larders. The roomy royal nursery is thimble-shaped. The queen lays an egg at the bottom of each cell where it is firmly fixed. A retinue of workers follows the queen as it goes about its labours. They feed the queen with a royal jelly, a salivary secretion of the workers, every time it pauses for rest. At the peak of the egg-laying period a queen can lay as many as 1,500 eggs, totally weighing more than its own weight. The high fecundity of the queen compensates for the short lifespan of the workers. But the queen's fecundity depends on the food it eats — the more jelly it gets, the more eggs it lays.

The care of the offspring is left to the young bees. The eggs hatch on the third day. The white larvae are fed on bee's milk for three days. The worker larvae are then fed with limited amounts of thinned honey, nectar and bee bread (pollen). The princesses, however, continue to get an abundant supply of bee milk, now called royal jelly. This jelly, rich in protein and fat, helps the princesses grow bigger than the stunted workers. It also makes them fertile. Drones are fed on worker food for eight days. Ordinary grubs are fed for only six days. After this they go into the pupal stage for 12 days from which they emerge as adults.



A bee against the backdrop of hexagonal-shaped cells of the honeycomb

The newly emerged queen utters a shrill piping note to which other royal bees respond. Potential rivals are located and fights settle the question of overall supremacy. Even infant queens respond to the piping from within their cells. The queen is quick in killing them by piercing their cells and biting.

The victorious new queen (the old queen usually swarms out to set up a new hive with a set of workers) now moves around the hive, eating honey and sometimes flying out on short trips around the hive. Around the age of 10 days it sets out on its mating flights, pairing successively with four or five drones before returning to the hive. After pairing, the queen stores the sperm in a receptacle called the spermatheca. As each egg is laid, sperms are released by muscular action. Fertilised eggs produce queens and workers. Drones are born from unfertilised eggs — the spermatheca is closed while the eggs are laid in the drone nurseries. The queen's egg-laying function begins two days after mating and continues for the four or five years it lives.

The worker's life is different. The moment it emerges from its cell, it has to beg for food. After moving around the hive, it begins producing the royal jelly for the larvae. Its nursemaid duty finishes after about 12 days when the wax glands at the base of the abdomen begin to function. It then starts its building and repairing job. By this time it goes out on short reconnaissance flights to acquaint itself with the geography of the hive. It then takes up domestic duties — relieving homecoming foragers of their burdens and acting as a guard. All members of the hive can be identified by their particular odour. However, if a strange bee laden with nectar strays in, it is not threatened or attacked. In a short time it too acquires the hive odour.

With the completion of the domestic period at the age of three weeks, the worker now becomes a breadwinner. It flies into the world of flowers in search of nectar, pollen, water and resin. The resin is converted into a soft varnish called propolis which is used for sealing crevices, lining wax cells and plastering down debris and waste that cannot be carried out of the hive. Depending on the number of trips it makes, the worker lives for four to six weeks.

If a colony is suddenly deprived of a queen and if the royal nurseries have no princesses, the colony will die if there are no worker larvae less than three days old. The disturbed colony makes emergency adjustments at this stage. It enlarges a worker larva's cell, feeds the larva on royal jelly till it grows into a new queen. The younger the larva, the more suitable it is for a queen. Experimental feeding of young workers on a protein diet however did not yield queens. This shows that certain hormones are also included in the royal menu.

The honeycomb consists of hexagonal wax cells on either side separated by a thin wall in the middle. Some bees (the bumble bees of the family Bombidae) build round-celled combs. The wax is obtained from the honey eaten by the bees — four kilograms of honey yield one kilogram of wax. The walls are first built thick, then thinned down to the required size. The honey bee is a master designer — its cells are so shaped that it gets the maximum storage space with the minimum use of wax. The cells slope downwards to the closed end in order to reduce spilling.

The best of care is taken to maintain a proper temperature and humidity in the hive. Bees cluster together to prevent any loss of heat and spread out and fan their wings when coolness

QUEEN

WORKER

DRONE

and ventilation are needed to keep the wax from softening. The comb is built downwards from a horizontal support. The ceiling is thus firmly sealed to trap all warmth. The honeycombs are on the outer side with the nurseries inside. The nurseries are thus well insulated against the cold.

Bees are classed along with ants, wasps and sawflies in the order *Hymenoptera* which includes several families of bees. Some bees are completely solitary. They lay eggs, provide the larvae with sufficient food and there their responsibility ends. Others are partly social. At the end of the cold season the colony dies out; the fertilised female hibernates and wakes later to start a fresh brood in the spring. Unlike the honey bee queen, this queen is quite capable of finding food and building nests. But the first brood saves it the trouble and thereafter it just does nothing but reproduce. Bumble bees have this social pattern.

Apart from their hundreds of enemies which include the honey-loving mammals and insects and the wasps and birds who feed on them, there are also other parasite bees (belonging to a closely related genus) that stealthily lay their eggs in any hive; they are like the cuckoo which lays its eggs in the crow's nest (which earns them the name cuckoo bees). Each genus has its particular parasite. But bees have survived these parasitic associations and have continued to make their golden food that man has come to relish so much.

Fan That Swings All Around

MOST electric fans have a limited span of oscillation. A mechanism which enables a fan to oscillate at any angle in a sweep of 360° has been invented by S. S. Jain of Roorkee. The sweep governing the fan essentially comprises an electric motor and an oscillation mechanism with the associated cam and gear arrangement. The whole assembly, together with the fan blades, is mounted on a stand and can be rotated about the central shaft. Current to the motor is fed through slipping conductors, eliminating the use of wires.

The fan carries a knob, a pointer and a scale marked in degrees from 0 to 360. The pointer can be set at any angle in increments of 5° or even less. At 0° the fan does not oscillate, but at 360° it oscillates or rotates about its base in a full circle.

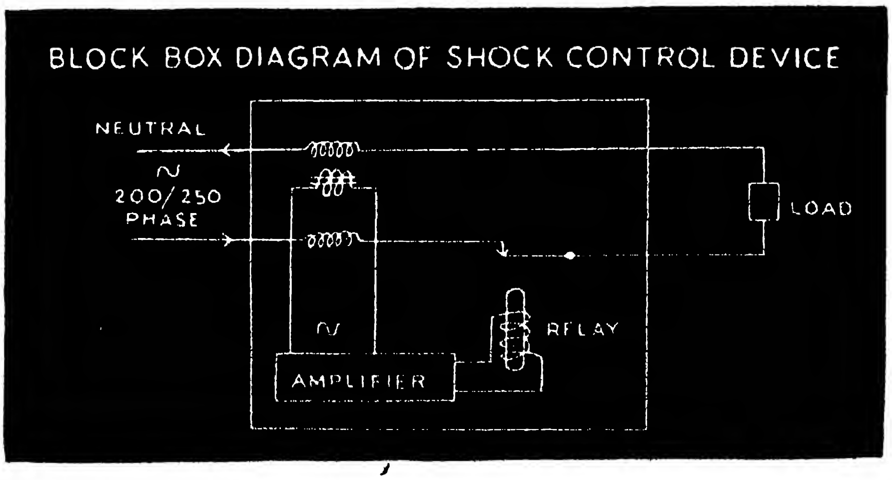
No More Electric Shocks

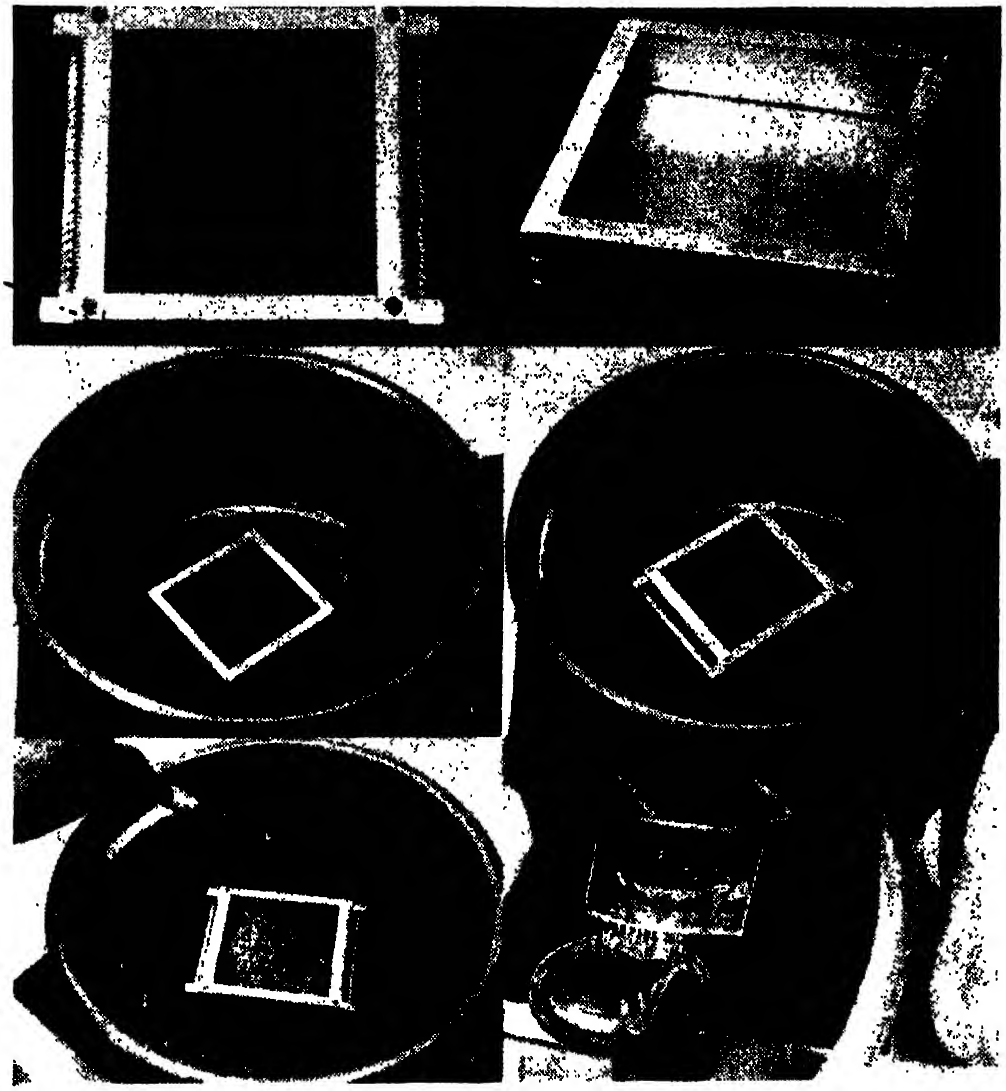
ELECTRIC shock hazards have become a matter of serious concern with the increasing use of electrical gadgets in homes and industries. Electric shocks kill about a thousand people every year in India, including fatalities in power stations and on transmission, distribution and domestic supply lines. Non-fatal cases number another thousand. A shock control device invented by A. Joseph Stephen of Tiruchi, Tamil Nadu, holds great promise as a safeguard against electrocution. It cuts off the power supply automatically almost the moment a person comes in contact with a live point. Any shock he receives will be very mild.

Scientists had been working along a number of lines to tackle the problem but had failed to produce a foolproof system. Direct earthing of metallic parts, earthing of a neutral point, double insulation and the use of differential relays of normal sensitivity had been tried earlier, but the results were not very satisfactory. Protection by high-sensitive differential relays seemed to be the surest method. Efforts to develop a reliable device are still going on in several laboratories throughout the world.

The Tiruchi inventor's device basically comprises two inductive coils coupled to a third one which is linked to a sensitive relay. Any change of current in the first two coils generates a magnetic field. So when a load is connected to the delivery side of the device across two supply lines, both the coils have equal current and, therefore, a zero field around them. When a person touches the phase line on the delivery side, the circuit is completed through the ground and the neutral coil, causing an excess flow of current through one of the coils. The differential current so created induces a magnetic field around the two coils, which is picked up by the third coil and fed to a transistorised amplifier. The amplified signal actuates the sensitive relay which cuts off the phase supply line automatically.

The device responds within 0·05 second and needs only 5mA current leakage for its working. It is installed just after the main switch and can be connected to 230–250 volts AC 50 cycles/second single phase.





1. top, left: Screen for separation of pupae, consisting of an aluminium frame with an opening 10 cm square (inside dimensions) crossed by evenly spaced nylon threads under tension

2. top, right: Aluminium tray, 10 cm square, for holding pupae

3. middle, left: Tray with pupae in plastic tub

4. middle, right: Tray holding pupae covered with screen in plastic tub

5. bottom, left: Separation of pupae by the addition of water to the tub. Small (mostly male) pupae pass through the screen while large (mostly female) pupae are retained

6. bottom, right: Collection of separated pupae on nylon net at overflow spout from tub

Mosquito Separation

MOSQUITOES, like other insects, develop immunity to many insecticides. According to WHO, over 100 insecticides are now found ineffective against many types of mosquitoes, including those which cause diseases like malaria and elephantiasis.

One of the modern techniques of mosquito control is to release sterilised male mosquitoes. The male mosquitoes are separated from the females and sterilised by radiation. The separation must be done in the pupal stage or shortly after the adult emerges as mating can occur within 24 hours thereafter. In many mosquito species, the sex can be easily determined in the pupal stage by size—the male pupae being smaller than the female. Pupal separation is done in laboratories for studying the genetics, insecticidal susceptibility and vectorial capacity of mosquitoes. The devices used for this purpose are expensive and complex and are not very satisfactory.

Dr. Vinod Prakash Sharma of New Delhi has now come up with a novel device that is simple in operation, inexpensive and extremely efficient. It consists of a screen of evenly spaced parallel nylon threads (0·8 mm in diameter) held under tension by two side bars of an aluminium frame (10·16 cm × 10·6 cm). The frame has 53 threads and the opening between the threads is 1 mm, just sufficient to permit the small male pupae to pass.

The pupae to be sexed are kept in an aluminium tray of the same dimensions as the screen frame. The tray is placed in a plastic tub and covered with the screen. The tub is then filled with water, and the small pupae, mostly males, passing through the screen float to the surface.

Badiuddin Khan

YOU TOO CAN DO IT

ELECTRONIC RELATIVE HUMIDITY METER

THERE are bright, clear days when the temperature seems just right. Yet you experience a feeling of discomfort. There seems to be a dryness in the air. Or often on gloomy days you keep sweating profusely. This comes about not because of the temperature of the air but because of its humidity. Humidity is the percentage of moisture in the air. If you were to place a little water in dry air, very soon the water evaporates and the vapour mixes with the air. This evaporation continues till the air can hold no more vapour. The air is now saturated with water vapour. The amount of moisture the air can hold depends on the temperature of the air (see Fig. 1).

The air is rarely fully saturated with moisture. When a measurement of the humidity of the air is taken, it is referred to as the relative humidity of the air. This relative humidity is the ratio of the amount of water vapour in the

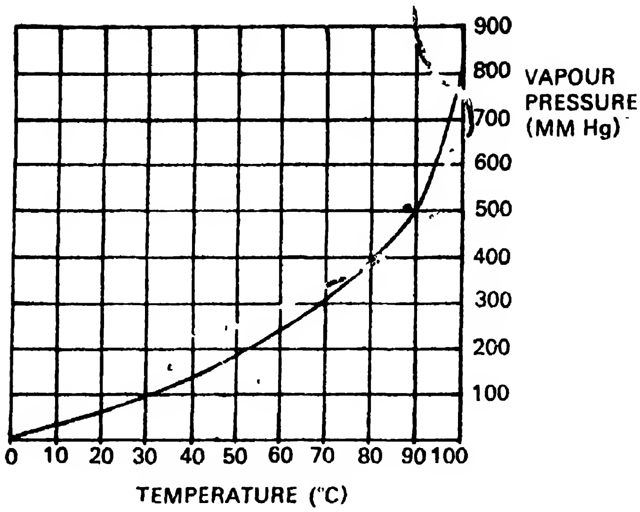
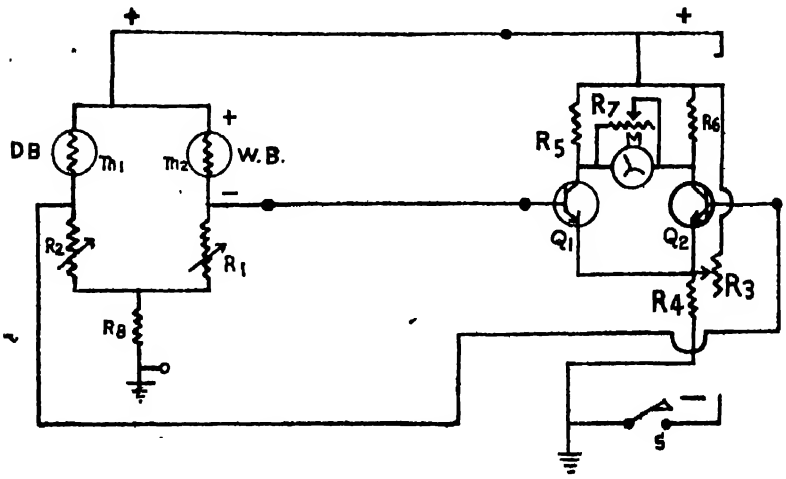


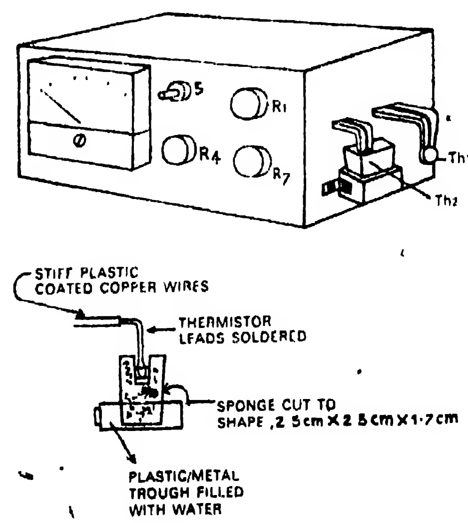
Fig. 1 Graph illustrating the relationship between temperature and the water vapour pressure in a fixed volume of air

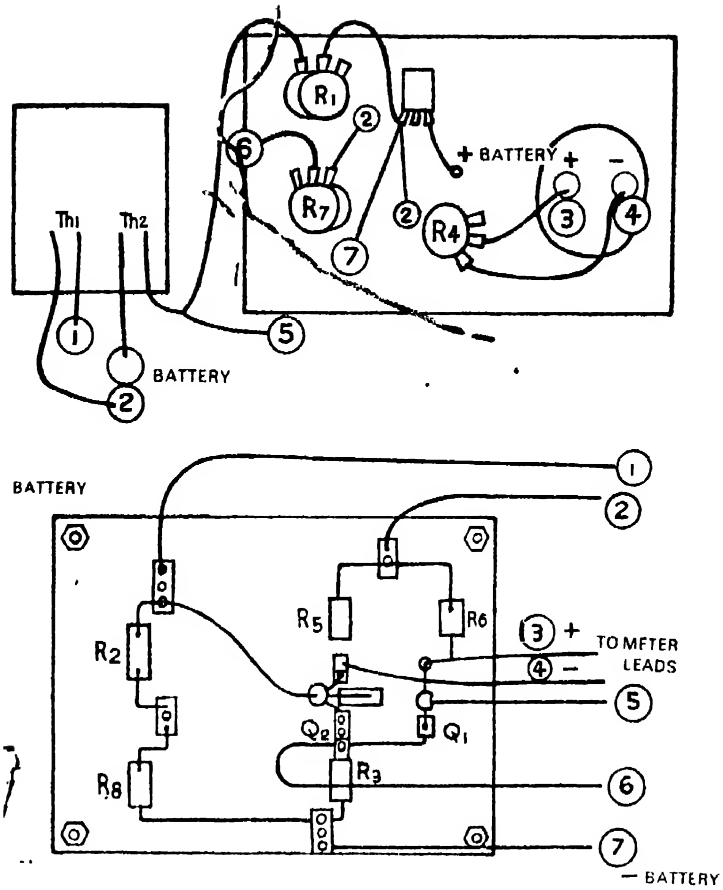
air to the total amount of water vapour the air can absorb. In other words, relative humidity is the percentage of water vapour in the air where the total saturation is referred to as 100 per cent. Hence, when the relative humidity at a certain temperature is said to be 50 per cent, it means the air contains only 50 per cent of the maximum amount of water vapour it can hold at that temperature. But since humidity depends on temperature, a relative humidity of 25 per cent at 26·6°C will be 40 per cent at 19·4°C and 50 per cent at 16·1°C.

The earliest methods for determining the humidity of air were primitive. Catgut, sheep's

Fig. 2 (**left**) **The circuit of the electronic relative humidity meter**
Fig. 3 (**right**) **The position of the thermistors**







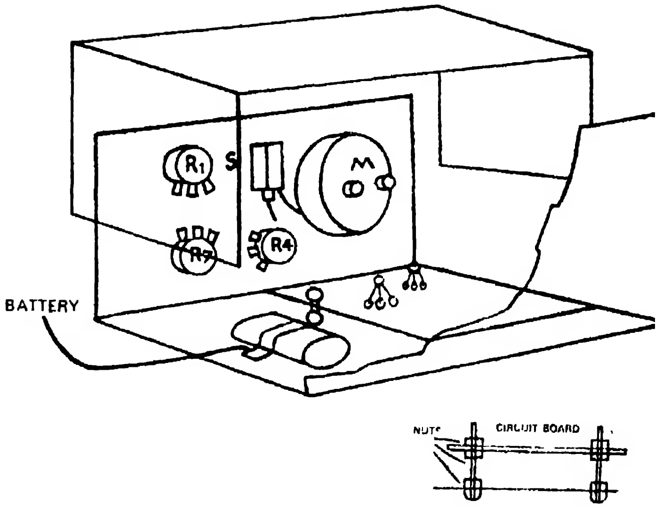


Fig. 4 (left) The wiring of the electronic relative humidity meter

Fig. 5 (top, right) The meter and case adjustments

wool and gold beater's skin were the commonly used sensing elements. These have the common property of changing their length according to the relative humidity of the air. The newer devices are the wet and dry bulb thermometers. These consist of two thermometers, one to measure the temperature of the air and the other to measure the dew point. The difference between the two readings determines the relative humidity.

But you can build your own " hygrometer " to measure the relative humidity of the air. This hygrometer consists of two thermistors (temperature-sensitive resistors), one of which measures the air temperature and the other the temperature of the water in the air. The unit computes the relative humidity by measuring the resistance of the thermistors and amplifying the difference in the resistances. This amplified difference is shown on the meter.

This is how the device works. If there is a fall in temperature, the thermistor Th2 changes its resistance (it increases). The emitter-base voltage of Q1 rises by a definite value as a result. Q1 then conducts, thus enabling the meter to give a reading. Th1 compensates for temperature changes. R1 is for the adjustment of the meter, R7 for the adjustment of scale length and R4 for the adjustment of sensitivity.

The entire circuit (Fig. 2) is assembled on a perforated phenolic board and has push-in terminals. The thermistors are mounted as in Fig. 3. The wiring is shown in Fig. 4. Figure 5 shows the meter and case adjustments.

You will need:

Thermistors: Th1 and Th2. *Resistors:* R1 — 100 ohms, 1 watt, wire wound potentiometer; R2 — 50 ohms, 1/2 watt, carbon; R3 — 1 K ohm, 1 watt, wire wound potentiometer; R4 — 500 ohms, 1/2 watt, wire wound; R5 and R6 — 500 ohms, 1/2 watt, carbon; R7 — 200 ohms, 1 watt, wire wound potentiometer; R8 — 50 ohms, 1/2 watt, carbon. *Transistors:* Q1 and Q2 — CIL 521. *Switch:* S — SPST Toggle. *Misc:* Aluminium case. *Meter:* M — 0 to 100 μA.

F. Rehman

What would happen if the ice-caps melted?

THE Earth's land areas carry a load of nearly 37 million cubic kilometres of ice (about 85 per cent of it on the continent of Antarctica). Since water is somewhat denser than ice, this load of ice would melt down to about 33 million cubic kilometres of water.

Naturally, if the ice melted, almost all that water would run off the land areas into the ocean. The ocean has a total surface area of 364 million square kilometres. If that surface area remained constant and the 33 million cubic kilometres of melted ice were to spread out evenly over the top of the ocean, it would be 23/250 or 0·092 kilometres thick. This means that the layer of melted ice would be 91·5 metres thick.

However, the surface area of the ocean would not remain constant, for if its level rose it would spill out over about four million square kilometres of the low-lying land areas along its shores. This means the ocean's surface area would increase and the layer of new water would not be as thick as we have just supposed. Furthermore, the added weight of water would depress the ocean bottom somewhat. Still, the ocean level would probably rise 61 metres, enough to reach the twentieth storey of the Empire State Building and to drown much of Earth's most densely populated areas.

Throughout Earth's geologic history, the quantity of land-ice has varied considerably. During the height of an ice age, kilometres-high glaciers advance over millions of square kilometres of land and the water level of the oceans drop so much that the continental shelves are exposed as dry land.

On the other hand, when the ice-load is virtually zero, as it has been for tens of millions of years at a time, the ocean level is high and the continental area small.

Neither situation is necessarily catastrophic. At the height of an ice age, millions of square kilometres of land are covered by ice and are uninhabitable to land life. On the other hand, millions of square kilometres of continental shelves are exposed and habitable.

If, contrariwise, the ice is gone, millions of square kilometres of land are covered by water and are uninhabitable to land life. On the other hand, without ice, and with smaller land areas, the climate is more equable and there are few deserts, so that a larger percentage of what land surface is left is habitable. And the change in total ocean volume is comparatively small (six or seven per cent at most), so sea life is not much affected.

If the change in sea-level were to take place over thousands and tens of thousands of years as it always has in the past, man could well cope with the change. The difficulty is, however, that man's technology is pouring dust and carbon dioxide into the air. The dust tends to cut off solar radiation and cool the earth, while the carbon dioxide tends to trap heat and warm the earth. If one effect predominates much over the other in times to come, earth's temperature may fall or rise comparatively rapidly. Continental glaciers may form or the ice-cap may melt in a matter of 100 years or so.

It will then be the rapidity of the change, not so much the change itself, that will be catastrophic.

Isaac Asimov

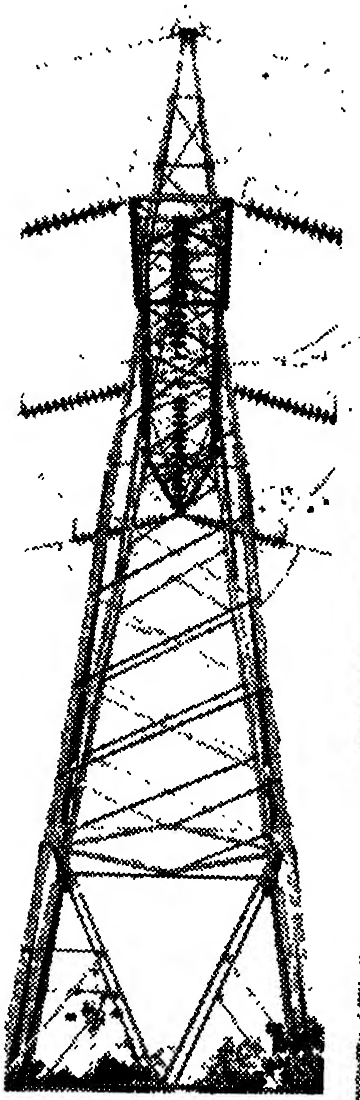
ABOUT THE AUTHORS

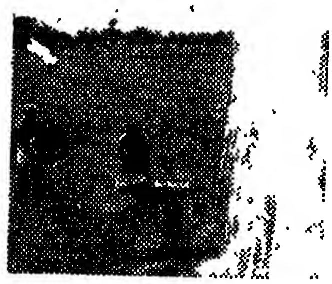
V. S. VENKATAVARADAN (*Mars — Is It Alive?*) is a Fellow at the Tata Institute of Fundamental Research, Bombay. For his PhD from Bombay University, Dr. Venkatavaradan worked under Prof. D. Lal of the TIFR with whom he was also a co-investigator on the Apollo-12 Moon rock samples. His research interests include planetary physics and the origin of elements.

M. R. DAS (*Hunt for Cancer Viruses*) is a Reader in molecular biology at the Tata Institute of Fundamental Research, Bombay, and is currently working on the molecular biology of tumour viruses. He had worked with Prof. Sol Spiegelman at the National Institute of Cancer Research, Columbia University, USA, on nucleic acid interactions and the molecular biology of tumour viruses for about two years before he returned to India in May 1970. Dr. Das had earlier written on *Genetic Information Transfer* in SCIENCE TODAY, December 1970.

LET THIS LAND BE POWER FED !

— *said somebody*

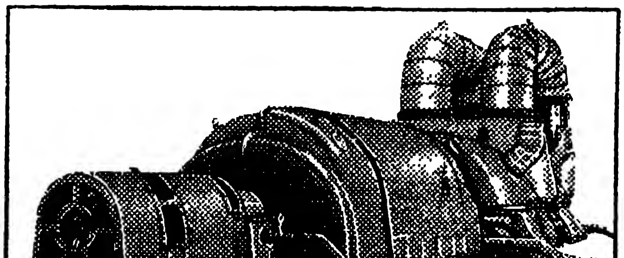




"Amen," said we.

And thereby hangs a tale. The tale of BHEL, Hyderabad, which, in a short span of three years since commencing production, has produced 110,000 KW and 60,000 KW Turbosets for use in Thermal Power Stations in Andhra Pradesh, Bihar, Delhi, Haryana, Punjab, Uttar Pradesh and Tamil Nadu. In Ennore, Tamil Nadu, two 60,000 KW Turbo-Generator sets supplied by BHEL, Hyderabad, with matching boilers supplied by the Tiruchy Unit, have been commissioned and connected to the Power Grid.

Power from these sets — and more under production — will carry electricity to cities, industrial centres and remote rural areas — lighting up thousands of homes, and activating enough pumpsets and tubewells to irrigate vast areas of farmland.



BHARAT HEAVY ELECTRICALS LTD.

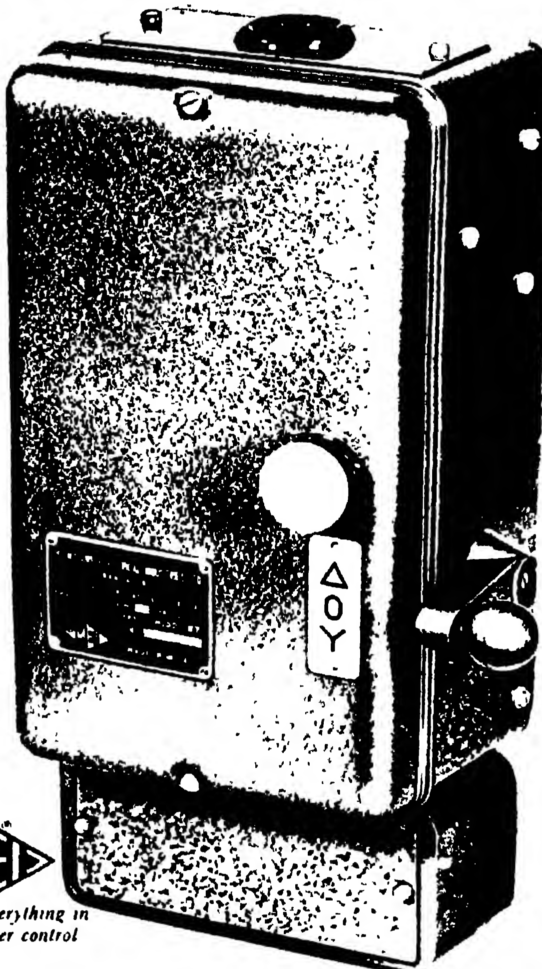
(A Govt of India Undertaking)

Ramachandrapuram, Hyderabad-32

Regd Office, 5, Parliament Street, New Delhi-1

FOSBHEL-1579B

Regd. No. MH 1368



MEI

safest for everything in electric power control

MSDD/NT MOTOR CONTROL STARTER THAT'S A PROTECTION TO MOTORS AGAINST OVERLOADS

Accurately calibrated thermal bimetallic relays to provide sensitive tripping make the MSDD NT Star-Delta Starter the best all-round protection you can give your motors today. Its very simplicity of design not only assures continuous fool-proof performance under severe conditions, but also makes its operation and maintenance easy—and safe!

More Special Features:

Undervoltage coil takes care of voltage fluctuations from 380 v. to 440 v.—e.g. in rural areas.

Wiping action of moving drum contacts ensures longer contact life. Contacts, moreover, are easily replaceable.

Extra space for easy connection of cables with aluminium conductors.

Completely dust-tight and vermin-proof.

Rugged in construction, stays unaffected by rough use. Yet, highly compact and elegant in appearance.

Manufactured by

THE MYSORE ELECTRICAL INDUSTRIES LTD. BANGALORE

Sales & Service

I.A.E.C.

(BOMBAY) PVT. LTD.

43, Forbes Street, Bombay 1.

Branch. 'K' Block, Chawdhary Bldg Connaught Circus, New Delhi

Associated Offices

Calcutta . Madras . Bangalore . Hyderabad

B. Dattaram-MEI-131A

A TIMES OF INDIA PUBLICATION

MARCH 1972

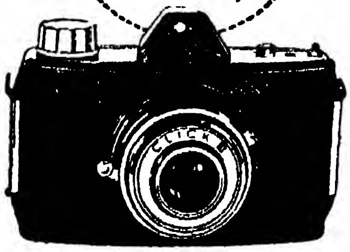
SCIENCE TODAY

FOR EVERYMAN

MUST WE MANIPULATE MAN?

GENETIC ENGINEERING

Rs. 1.25



Vol. 6 No. 9 March 1972

SCIENCE TODAY

COVER Man's power over nature also implies man's power over man. Wisdom lies in letting nature have her way. (*Designed by Shabbir Diwan*)

Annual Subscription Rs. 12·50
Single copy: Rs. 1·25; 10p

Editor
Surendr Jha

Printed and published for the proprietors Bennett, Coleman & Co., Ltd., by Pyarelal Sah at the Times of India Press, Bombay, India. Delhi Office: 7, Bahadur Shah Zaffar Marg, New Delhi 1; Calcutta Office: 13-1 and 13-2, Government Place East; London Office: 3, Albemarle Street, W.1.

ABOUT THE AUTHORS

A. K. MALHOTRA (*Let's Churn the Oceans*) is member of the National Committee on Science and Technology and is working with Engineers India Limited (a consulting company in the public sector) in charge of its Offshore Engineering Department, which is developing expertise in offshore oil exploration, production, transportation and storage engineering, marine surveys and other oceanographic investigations.

A BTech from IIT, Kharagpur, he took his Master's degree from MIT (USA) and a Doctorate in Engineering from the University of California at Berkeley. He had earlier worked as a consulting engineer on problems of space structures in Cambridge, USA, and on the design of offshore structures for deep water in California. He was awarded the Homi Bhabha Fellowship for "a study of the system and technological requirements for offshore oil exploration and production in India".

K. T. M. HEGDE (*Metallurgy in Ancient India*) is Reader in Environmental Archaeology at the MS University of Baroda. His main interests are ancient Indian technology, conservation of antiquities and the geochronology of the Quaternary period; he obtained the PhD degree for his thesis on the Chalcolithic Period Copper Metallurgy in India.

Dr. Hegde was with the Archaeological Survey of India for about 7 years before he joined the MS University. Last year, he was elected a Fellow of St. John by the University of Cambridge, England, where he will teach and do research during the next academic year.

LEON R. KASS (*Must We Manipulate Man?*) is Executive Secretary, Committee on the Life Sciences and Social Policy, National Research Council, National Academy of Sciences, Washington. The article is adapted from a working paper prepared by the author for the committee, and from his lectures.

STATEMENT ABOUT OWNERSHIP AND OTHER PARTICULARS ABOUT NEWSPAPER ENTITLED "SCIENCE TODAY", BOMBAY.

FORM IV (See Rule 8)

1. Place of Publication:	The Times of India Press, The Times of India Building, Dr. Dadabhai Naoroji Road, Bombay
2. Periodicity of Publication:	Monthly
3. Printer's Name:	Shri Pyarelal Sah for the Proprietors: Bennett, Coleman & Co. Ltd.
Whether Citizen of India:	Yes
Address:	Rehmat Manzil, 2nd Floor, Flat No. 8, 75, Vir Nariman Road, Bombay
4. Publisher's Name:	Shri Pyarelal Sah for the Proprietors: Bennett, Coleman & Co. Ltd.
Whether Citizen of India:	Yes
Address:	Rehmat Manzil, 2nd Floor, Flat No. 8, 75, Vir Nariman Road, Bombay
5. Editor's Name:	Shri S. K. Jha
Whether Citizen of India:	Yes
Address:	3-A, Somerset Place, Sophia College Road, Bombay 26 WB

6. Names and addresses of individuals who own the newspaper and partners or shareholders holding more than one per cent of the total Paid-up Capital as on 4–2–1972 :

SHAREHOLDERS

(1) Bharat Nidhi Ltd., 5, Parliament Street, New Delhi

(2) Messrs. Sahu Jain Ltd., 11, Clive Row, Calcutta-1

(3) Ashoka Viniyoga Ltd., 11, Clive Row, Calcutta-1

(4) Messrs. Sone Valley Portland Cement Co. Ltd., Japla Cement Factory P.O., Japla (E. Rly), Bihar

(5) Messrs. Sahu Properties Ltd., 18A, Brabourne Road, Calcutta-1

(6) The Dehri-Rohtas Light Railway Co. Ltd., Dalmianagar, Bihar

(7) Shri Ashok Kumar Jain, 'Times House', 4th Floor, 7, Bahadur Shah Zaffar Marg, New Delhi

(8) Shri Manoj Kumar Jain, 11, Clive Row, Calcutta-1

(9) Smt. Indu Jain, 11, Clive Row, Calcutta-1

(10) Shri Alok Prakash Jain & Smt. Indu Jain, 11, Clive Row, Calcutta-1

I, Pyarelal Sah, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Date: 1-3-1972

P. L. Sah
Signature of Publisher

AWARDS & APPOINTMENTS

Prizes for Inventions

DR. C. R. Marathe, Indian Institute of Technology, Bombay, has won the highest award of Rs. 10,000 in the Republic Day Awards for inventions. Totally 35 inventions have won the awards.

Dr. Marathe's "mirror screen" provides two projections of a film from a single projector. Installed behind the usual celluloid screen, the mirror screen reflects the obverse image on the first screen, thus giving a second projection (see SCIENCE TODAY, July 1966). The device has been introduced in two theatres in Bombay and Poona.

Josef Nojedly, Praga Industries Ltd, Coimbatore, wins an award of Rs. 5,000 for his bullet-proof, lightweight helmet made of plastic-reinforced glass fibre.

Mohinder Singh Dadiala of Dadiala Engineering Works, Delhi, has been awarded Rs. 5,000 for a paper-bag manufacturing machine.

The other award winners are:

Hans Raj Longani and T. L. Chadda (Rs. 2,000), New Delhi, for an automatic gas burner—an electrically operated gadget with a gas valve.

Santokh Singh Khatra (Rs. 2,000), Calcutta, for a foot-operated insecticide spray pump. Two bellow-type pumps in the heels of the shoes alternately pump compressed air into a container carried on the back by the operator. The compressed air sprays the insecticide through nozzles.

U. S. Patil (Rs. 2,000), a science teacher from Nandurbar, Maharashtra, for making lead pencils from jowar stalk.

The following have been awarded Rs. 1,500 individually or jointly:

Chandra Mohan, Punjab Tractors, Chandigarh, G. S. Rihal and B. S. Devgun of Central Mechanical Engineering Research Institute (CMERI), Durgapur, for improvements in tractors which reduce the number of levers for working the finger-tip automatic depth-cum-position control hydraulic system. This improves the manoeuvrability of tractors, particularly in small fields. S. K. Bhattacharya, S. C. Basu and A. K. Bandopadhyaya, CMERI, for an all-aluminium condenser which saves on copper; Dr. Y. Nayudamma, D. Mukherjee and K. T. Sarkar, Central Leather Research Institute, Madras, for the production of "syntan", a synthetic tanning agent for white tanning, prepared from indigenous materials; Dr. H. V. K. Udupa and K. C. Narasimham, Central Electro-Chemical Research Institute (CECRI), Karaikudi, for lead dioxide electrodes used in the production of chlorates and perchlorates of sodium, etc; Dr. A. Singh, V. Chandra and Dr. L. D. Kapoor of National Botanic Gardens, Lucknow, for an improved apparatus for the production of *attar* and perfumed water; B. K. Choudhuri, A. C. Dutta and N. T. Parmeswaran, Defence Research Laboratory (Materials), Kanpur, for a photo-sensitive synthetic resin lacquer from indigenous materials. This is used for etching purposes. Dr. Y. Nayudamma, Mrs. R. Khanna, P. S. Venkatachalam, J. Khanna and K. B. Gupta, CLRI, for a special "bandhani leather" using a new technique of dyeing leathers; and B. A. Shenoi, R. Subramanian and S. Chakrapani, CECRI, for a new solder and flux for jointing aluminium cables.

Two Allahabad students, Ajoy Kumar Ghosh, an engineering student, and Jagdeva Prasad Gupta, a medical student, won Rs. 1,000 each for their inventions. Ghosh developed an ellipse tracer which is simple and easy to operate. Gupta built a mechanism that makes a fan rotate, oscillate or work in a fixed direction about a vertical axis.

Others who individually or jointly got Rs. 1,000 are:

Ravindra Nath Seth, Research Designs and Standards Organisation (Railways), Lucknow, for a semi-automatic anchoring and locking device for containers used in rail or road vehicles; Dr. M. Anandakrishnan and P. Basak, Indian Institute of Technology, Kanpur, for an apparatus for the determination of radial permeability; Dr. S. K. Bharat and Mahendra Kumar, CLRI, for a process for the treatment of mammalian intestines from slaughter houses for the manufacture of absorbable surgical catgut, suture or ligature; and Dr. Sisir Kumar Barat, CLRI, for a process for dyeing woollen hair and other keretinous fibres into a fast non-bleeding jet black shade without using any dyestuffs as in the conventional method.

Besides, 4 prizes of Rs. 500 each and 12 certificates of merit have also been awarded.

IN THE FORTHCOMING ISSUES...

SUPERCONDUCTIVITY

SPEECH DEFECTS

NUCLEAR POLICY FOR INDIA

US-USSR SPACE DOCKING

BURNS AND FIRE HAZARDS

SCIENCE SHAPES LIFE

VACCINE FOR DIABETES

Viruses may cause diabetes, particularly in children, according to *Lancet*, a leading medical journal. An editorial in the magazine suggested if scientists substantiate these findings, "the possibility of attempting to prepare a vaccine (against diabetes) must then be considered". According to the new concept, viruses damage the pancreas gland, which produces insulin, the hormone that controls blood sugar. All investigators cautioned it would take years to prepare a hypothetical vaccine — if one is ever produced.

OTHER SIDE OF THE POPULATION BUG

The prophets of doom might pause a while to digest these findings of Jean Bourgeois-Perhat of France's National Institute of Demographic Studies. He found that the birthrate is falling nearly everywhere in Europe. France is keeping slightly above the replacement level. But in West Germany, Sweden, Czechoslovakia, Denmark, Finland, Portugal and Hungary births are not keeping up with deaths. Switzerland, Austria and East Germany are approaching zero population growth. Britain, the Netherlands and Italy also exhibit a downward trend though they have yet to reach the ZPG level. Poland, climbing since 1968, shows no signs of levelling off. Russia, which experienced a severe drop in birthrate since 1960, is now bottoming out.

SMOKING LEADS TO SMALL BABIES ?

Medical opinion holds that small babies with a low weight at birth are more likely to die within a month or two than heavier babies. Does smoking in women lead to small babies? Some earlier studies had reported so, but this has been now challenged by a US researcher. After studying 5,000 cases, Jocob Yerushalmy of the University of California, Berkeley, found that certain behavioural and biological factors in women were more responsible for low-weight babies. Smoking was only a symptom of these behavioural traits.

Smoking mothers who gave birth to small babies were found to have many things in common. They were carefree, extreme in their habits, nervous and neurotic. They also menstruated early in life. And even before they took to smoking, there was a high incidence of small babies among such women. What is more important, small babies of smoking mothers were more healthy than small babies of non-smoking mothers. What then causes small babies? Yerushalmy concludes tentatively that "smokers represent a group of people whose reproductive experience would have duplicated the observed patterns whether they smoked or not".

ARTIFICIAL MUSCLE

Adam Morecki, Kazimierz Nazarzuk and Andrzej Proniewicz of the Warsaw Polytechnic, Poland, have submitted for patent rights a design for an artificial muscle. The muscle can be used for bioelectric control of artificial limbs and orthopaedic apparatus and mechanical manipulators replacing human limbs.

The application of an electro-pneumatic converter, a miopotentials amplifier and a storage battery has helped in considerably reducing the size of the equipment.

THE PUZZLING PULSAR

Cygnus X-1 has indeed proved to be a puzzling proposition and the focus of attention of numerous experimental and theoretical astrophysicists (see SCIENCE TODAY, July 1971). This X-ray pulsar has pulsation periods which vary between 1·0 and 10 seconds. Now the Royal Greenwich Observatory reports the Cyg X-1 might be a black hole circling round a giant star.

Earlier Drs. B. Louise Webster and Paul Murdin identified the X-ray source with a supergiant star 6,000 light years away. Its power output was estimated to equal that of the Crab Nebula. Several optical spectra of the star showed that it had a sine-wave pattern velocity; the maximum and minimum speeds differed by 128 kilometres and occurred in a 5·6-day period. The velocity changes also correlated with fluctuations in the X-ray intensity.

The explanation for this velocity variation may lie in the phenomenon of the star puffing in and out of its atmosphere. Another explanation may be that it is moving round an invisible companion. The former explanation is unlikely because there are no detectable variations in the spectral lines. That means the second explanation, that Cyg X-1 is part of a binary-system, is more rational.

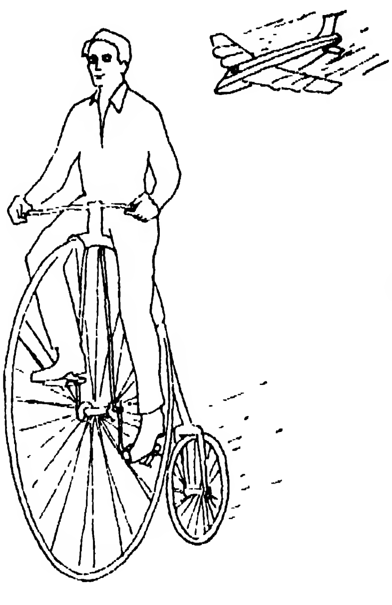
Blue supergiants are several times as massive as the Sun. The unseen partner of this binary system is calculated to be 2·5 solar masses. It generates huge tides in the atmosphere of the visible star. The unseen companion keeps attracting bits of the supergiant's atmosphere. The rapidity of X-ray variations suggests it is a small star. But it appears too big to be either a white dwarf or a neutron star. That means it could be a black hole — a supercollapsed form of matter that is the final point in the evolution of massive stars.

A CASE FOR THE BICYCLE

In an age of sleek automobiles and supersonic jets, trundling down on an old bicycle, after all, may not be a bad idea. Not bad, if fuel economy is your concern, and not just time. In this respect, cycling is the best means of transport, concludes a recent study by Richard A. Rice of Carnagie Mellon University, USA.

After analysing the efficiency of all forms of transport in terms of passenger-miles or ton-miles per gallon of petrol, and walking and bicycling in terms of gallon-mile equivalents of food calories used up, Rice came up backing the bicycle. It gives about 1,000 passenger miles per gallon (pmg). The modern vehicles trailed miles behind, the nearest being the double-decker suburban train chugging along at only 200 pmg. Then follow the 747 passenger jet (22 pmg), the 707 passenger jet (21 pmg), the motor car (about 21 pmg with 1·2 passengers) and the supersonic jet (13·5 pmg).

How do these transport fare now? Rail transport still dominates, particularly in inter-city transport, doing about half the total hauling on a tenth of the total fuel. Private automobiles consume about two-thirds of the total fuel for city transport. Airlines do not consume much fuel presently but in a decade, says Rice, they will account for 77 per cent of all transport energy. Is no one going to pay heed to Rice's study?



INSTANT TEST FOR PREGNANCY

A two-minute test for pregnancy is now available for physician, hospital and laboratory use. This is the first such test not to require refrigeration, and can usually detect pregnancy 12 days after the missed menstruation, or about 28 days after conception. The test, developed by Dr. Donald P. Goldstein of Harvard Medical School, USA, is based on an immunologic test for detecting human chorionic gonadotropin (HCG) in urine. Studies have shown that HCG, produced by placental tissue, can be detected by the test as soon as the foetus becomes implanted in the uterine wall.

CLEAN WATER FROM MANURE?

If you saw someone dumping cow manure, leaves and other assorted foliage into a lake, you'd probably think he was a polluter or a fanatic performing a strange mystic rite.

But far from destroying the lake, a scientist at the University of Missouri is pushing this recipe as a cure for acid-polluted waters caused by strip mining.

Dr. Darrell King, an associate professor of civil engineering, found that by adding waste organic materials — including raw sewage sludge — to acid strip-mine water, they got rid of the acidity and established a nice growth of aquatic plants in only 60 days.

"Many of Missouri's lakes have been in an acid state for 50 years," Dr. King said. "They support very little aquatic life of any kind — algae, fish, insects or plants.

"What we're trying to do is come up with a way to get them from this acid state to fishable, fish-producing lakes in less than ten years instead of the 50 or more years it takes now."

MINI-PLANET MAKES TRACKS?

Is there another planet closer to the Sun than Mercury? Dr. Henry C. Courten of Dowling College says that he has found what appears to be something orbiting the Sun closer than Mercury, but more work is needed to determine what it is. The object is about 14·4 million km from the Sun, Dr. Courten suggests. Mercury is 57·6 million km away.

The evidence is a number of mysterious tracks on photographic plates made during the solar eclipses of 1966 and 1970. These tracks do not have the characteristics of comets. The astronomer postulates that the tracks may be caused by an asteroid or perhaps a planetoid some 800 km in diameter.

LASER MEASURES GLACIAL MOVEMENT

The associates of the Arctic and Antarctic Institute in the USSR are using the laser beam to study the movement of Antarctic glaciers. The speed of the movement of glaciers is so insignificant that it is very difficult to observe by usual methods. In this experiment, scientists are recording glacial motion by the laser beam reflected from a mirror 20 centimetres (about 8 inches) in diameter which is attached to the glacier. Recent findings indicate that there is no specific pattern in the movement of glaciers and they can move for several seconds or for several hours. These observations are important to science since the climate of the entire planet depends on a large degree on the behaviour of the Antarctic glaciers.

THE MOON IS HOTTER

The Moon has more heat than had been generally thought. These findings, relayed by radio from a hole drilled into the lunar surface by Apollo-15 astronauts, have convinced a number of scientists that current theories on how the Moon and planets formed have to be revised. As a result, it is now thought that during the Moon's birth a series of layers were laid down, producing a surface region rich in radioactive elements. Heat generated by this radioactivity melted much of the top layer when the Moon was young and accounts for the newly observed heat flow, scientists contend.

THUMB-SUCKING THERAPY

Thumb-sucking is normal for the first two years of life and should not be discouraged, according to a US orthodentist. After that, one must determine whether the thumb-sucking is meaningful before deciding on what to do about it.

For example, says Dr. Earnest Klein of Denver, if a five-year-old child is left with a babysitter while the parents are on a long vacation and starts sucking his thumb in the belief his parents have deserted him, the habit is then meaningful. There is a direct cause-and-effect relationship. But no treatment is needed. Love and affection will usually wean him away.

However, if the child continues to suck his thumb after their return, the dental scientist said, the psychological approach must be taken. This might consist of a habit-reminder, such as bitter medicine or adhesive tape wrapped around the thumb.

TAPE-RECORDS TO SAVE PORPOISES

Tape-recorded screams of killer whales may save some species of porpoise from extinction. A fishing clipper named *Queen Mary* set sail from San Diego, USA, recently on the first of two 30-day cruises designed to test a new tuna-fishing technique.

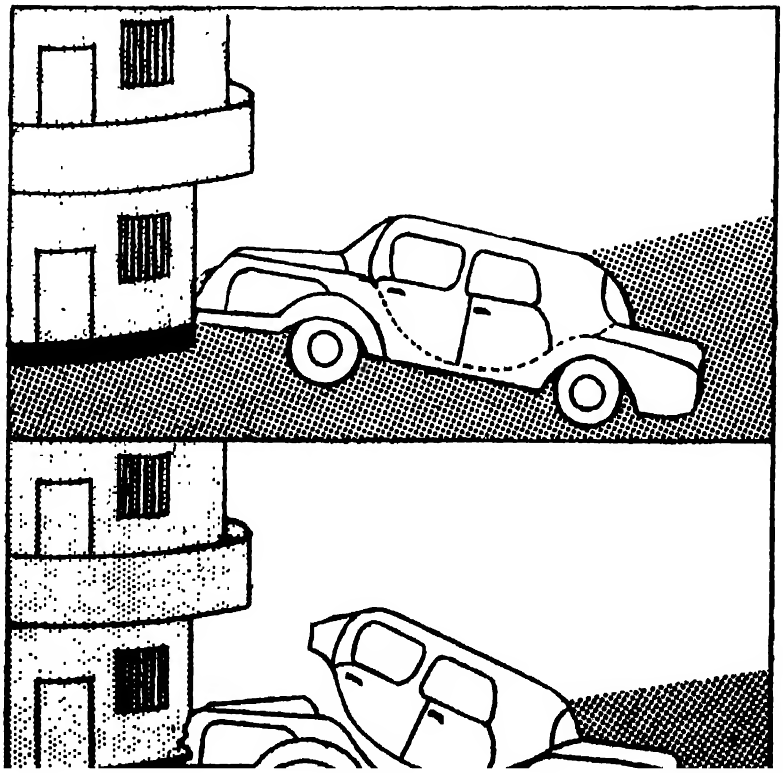
For unknown reasons porpoises and tuna tend to run together. So when a school of porpoises is spotted, the ship surrounds it with a fishing net about ·8 km in circumference, hoping to bring in a catch of tuna. But the porpoises, despite their ability to jump about 5 metres, become entangled in the net and drown. Their carcasses drop to the deck of the ship after being hoisted in with the rest of the catch. It is hoped that the broadcast screams of killer whales will send the porpoises fleeing from the tuna nets and thus avoid capture and death.

DRUGS IN ANIMAL FEED

The US Food and Drug Administration proposes to ban the use of antibiotics (tetracycline, streptomycin, dihydrostreptomycin, spectinomycin, neomycin, penicillins and sulfonamides) in animal feed. Since drugs used as human medicines are likely to be used in animal feed to test their efficacy, the FDA has told drug-makers to submit data on the safety and efficacy of the drugs used in animal feed.

KILLER DISEASE ON THE RUN

The classical view of Hodgkin's disease as inevitably fatal is no longer valid, according to Dr. Henry S. Kaplan, chairman of the Stanford Medical School's Department of Radiology in the US. Intensive radiation has dramatically altered the outlook.



TWO-PIECE CAR TO PROTECT PASSENGERS

An American inventor has come up with an entirely novel car design. He divides the whole car into two detachable compartments — the chassis and the passenger section. The passenger section is fitted on to the hollow in the chassis. When there is a crash, the chassis stops but the passenger compartment gets detached and simply slides apart, so that much of the impact is lost. A lever mechanism between the two compartments tilts the passenger seats back so that the passengers will be lying on their backs, safely cushioned against the shock.

Science Today March 1972

At one time Hodgkin's disease killed almost all its victims within five years. Today, 65 to 70 per cent of patients treated at Stanford are alive and well after five years. The percentage rises to 90 for patients in early stages of the disease.

Hodgkin's disease is a cancer of the lymphatic system, a network that extends throughout the body. In treating the disease, Dr. Kaplan applies supervoltage not only to the lymph nodes affected but to other apparently cancer-free nodes in the lymph chain to halt their progressive enlargement.

SMOOTHER OIL FLOW

A new method, called oil-water core flow, developed by Shell Oil is claimed to facilitate crude oil flow through an unheated pipeline; it reduces frictional drag in the pipe which usually slows down the flow. In the new method, oil and water are injected into the pipe at about the same velocities through special nozzles. The oil moves inside a jacket of water. A flow of 70 per cent oil and 30 per cent water is used currently.

LEAD-FREE PETROL CUTS VISIBILITY

Removal of lead from petrol can reduce visibility, indicates a recent US study reported in *Science*. Last year, Japanese tests had shown that lead-free petrol increased the emissions of "hydrocarbon, believed to cause photochemical fog".

Lead is added to petrol as an anti-knock agent: it helps the fuel to burn efficiently without knocking. Otherwise, expensive, high-grade octane fuel will have to be used. But lead is also a health hazard, being poisonous in the exhaust fumes. The latest studies show that leadless petrol spews a smoky exhaust gas of unburnt carbonaceous particles which decreases visibility by half. For tests, cars were run in a 2-km tunnel with clean air. A white light was shone along the tunnel and its intensity measured 800 metres away.

PIPE CLEANER ON PAWS

Ferrets, small skunk-like animals, are not known for much. The busy creatures are best known for their prowess at hunting down rabbits and an occasional rat. But the US Atomic Energy Commission has some big plans for the ferret. Felicia (above) has been employed at the AEC's National Accelerator Laboratory in Illinois, the world's largest atom smasher, to clean out its pipes. Equipped with cleaning cloth, Felicia crawls through 90-metre sections of the smasher's tubing. Some good housekeeping !

THE RAT TO END ALL RATS

An American scientist has nurtured a rodent strain that he says may be the rat to end all rats.

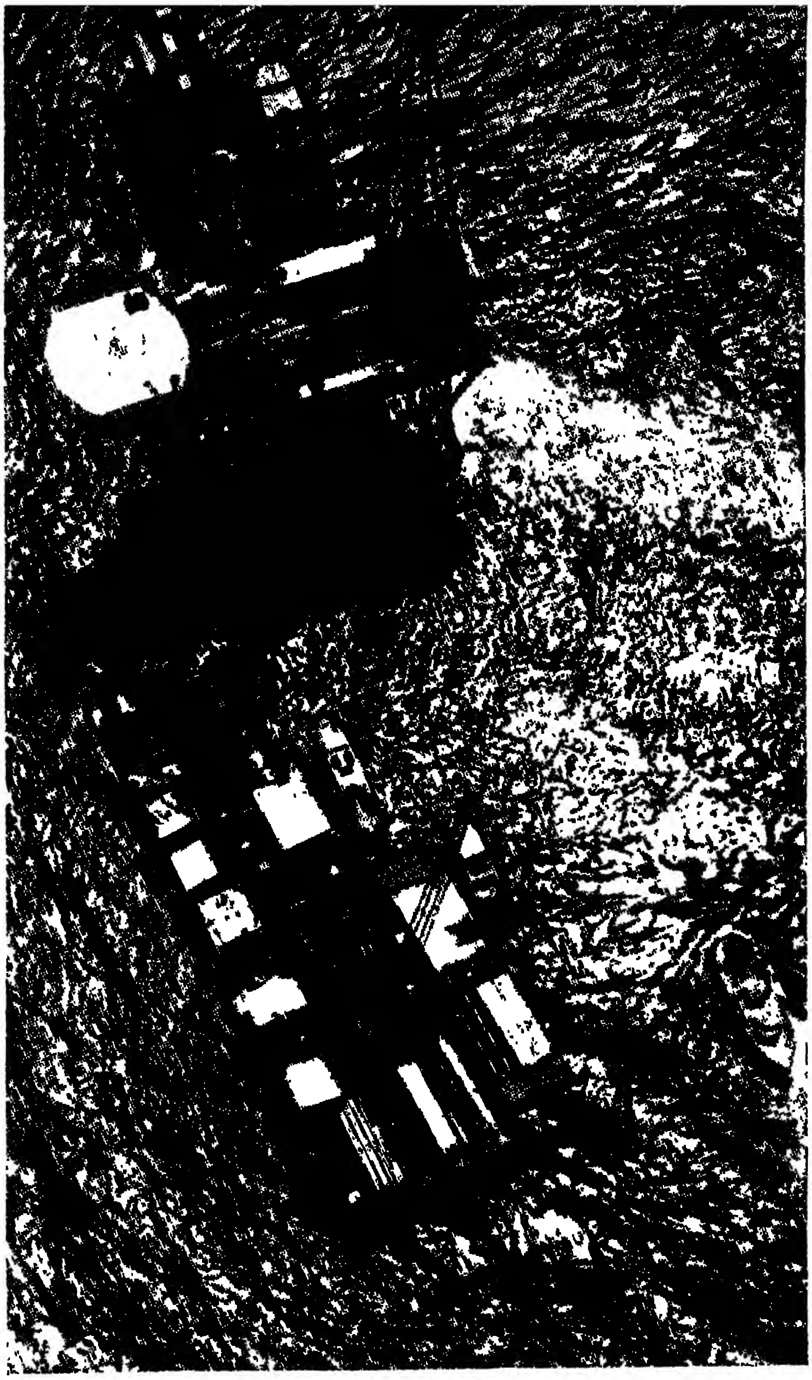
The animal is healthy and sexually vigorous, but it carries in its body a gene of sterility.

Dr. Allen Stanley, a physiology professor at the University of Oklahoma Medical Centre, says he has capitalised on a genetic flaw to breed a strain of the common brown rat that carries the seed of destruction.

"It's a sterility gene that — paradoxically — can be bred into the rats to reduce their number of offspring drastically," he said in an interview.

Dr. Stanley said the United States could reduce its rat population to below problem levels in less than eight years.

Let's Churn The Oceans



A. K. MALHOTRA

THE ocean and its inter-connecting seas form a continuous territory that cover about three-fourths of the earth's surface. Within these liquid expanses, there are almost inexhaustible sources of food, minerals and energy. Even the continental shelf of the world's oceans, that is the area covered by 200 metres of water or less, is greater in area than that of the Moon and it offers an almost virgin territory for those who would seek to explore it. Yet, man has been able to touch only an infinitesimal part of these riches. The main deterrent has been his incomplete understanding of the ocean.

True, the exploration and exploitation of the ocean's resources require a tremendous amount of initial investment in money and skills. Yet, the very complexity of this effort offers, paradoxically, opportunities for significant breakthroughs in our national economy. Development of marine resources such as fish, petroleum, sand and gravel, desalinated water, aquaculture, phosphorite and manganese nodules, placer minerals, extracted chemicals, fish protein

concentrates, etc are already possible with the available technology, and major countries of the world, recognising their potential economic importance, have already organised their efforts in this area. In India, however, consistent and co-ordinated efforts have not been made till now due to the absence of a formulated national policy, the unavailability of suitable technology and the lack of a project-oriented organisation charged with the specific responsibility of exploring and exploiting our marine resources.

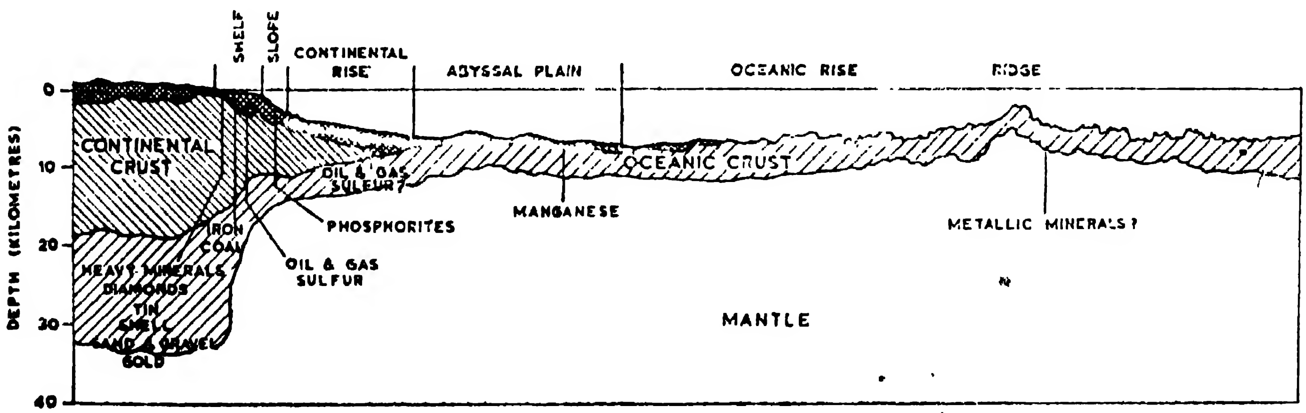
The sea — vital statistics

A proper consideration of marine resources should begin with a summary of the features characteristic of the deep ocean. The physiographic features consist mainly of a continental shelf extending from the beach to a width as large as 1,300 kilometres with outer depths of 50 to 500 metres, a continental slope slanting gently downwards from the shelf to the ocean depths of 3 to 5 kilometres at a slope of about 5°, and deep abyssal plains consisting of flat lands beyond the slope. Isolated mountain peaks dot these plains, occasionally rising high enough to become oceanic islands and mid-ocean ridges, with a rift valley along its middle, roughly bisecting the ocean basins (curiously, it also makes the longest continuous mountain range in the world).

The chemical features consist of a complex solution of dissolved chemicals with a surprisingly uniform content of approximately 40 chemicals constituting the common elements in the ocean's " salt ", and a vastly more dilute and less understood solution of trace elements, and organic constituents that support and permit life to exist within the sea.

The biological features consist mainly of a variety (over 10,000 known species) of one-celled plants called phytoplanktons that support all marine life through photosynthesis, and an almost equally large variety of tiny animals called zooplankton that drift with the currents; an enormous variety (over 100,000 species have been identified) of invertebrates; fishes which range in size from a few centimetres in length to the large game fish weighing 1,000 kilograms and more, and mammals (eg whales, porpoises, seals, walrus, etc) that form a curious classification that depends on the atmosphere for oxygen and includes some of the most intelligent animals in the whole sub-human kingdom.

The term 'resources', however, has an economic context, that is, the ocean must not only have the physical capability of satisfying certain human needs, but it must also be possible for these benefits to be attained without using up more goods and services than are gained in the process. It has been estimated that the production of marine resources—biological, chemical and geological — amounted to Rs. 79 billion in 1964; in the same year, the land areas had yielded an estimated Rs. 2,500 billion worth of production. Of this, chemical resources accounted for a total of Rs. 3·75 billion, Rs. 2·25 billion coming from the ocean. Biological resources provided a total Rs. 1,995 billion with only Rs. 47 billion coming from the ocean, and of the geological resources estimated at Rs. 573 billion, only Rs. 28·5 billion came from the ocean. It must be noted that all of the marine chemical and geological resources and about 90 per cent of all biological resources have come from the continental shelf.



Below: A schematic cross-section of a generalised ocean basin extending from the land (continent) out to mid-ocean ridge. Mineral resources occur in the topmost layer of sediments (cross-hatched); many of these minerals are economically exploited at the present time (taken from F. Wenk, Jr.)

Liquid granary ?

The major focus of marine activity today however, tends to lie in mankind's search for food and energy. The total population of the world, which now numbers about three billion, is expected to double by the end of the century and this has provoked an intense search for alternative sources of food. Of course, the sea can never satisfy the total food requirements of a very large sector of the human population. But it is an excellent source for a most critical element of the human diet, animal protein. Already some 15 per cent of the world's supply of animal proteins comes from the fisheries and it has been calculated that the potential yields, given the technology, is between 8 to 34 times the requirements. It has been estimated that ten grams of fish protein concentrate, a bacteriologically and biochemically safe and stable product of marine protein concentrate, could provide enough animal protein to meet the daily needs of a growing child at a cost of about Rs. 15 per year (the commercial production cost will not exceed Rs. 4 per kilogram). A ton of hake when processed yields 146 kg of concentrate containing about 114 kg of protein. There the problem, however, will be to get the people to accept the product.

It is interesting that the harvest of marine food has increased since 1945 at a rate which considerably exceeds the rate of growth of human populations. From 1955 to 1965, the commercial catch of fish increased at a compounded rate of more than 6 per cent per year. In part, this large increase resulted from exploiting fish stocks in highly productive areas of the oceans which had not been harvested before and also from the introduction of modern fishing methods such as factory ships and catchers. The Indian Ocean produces only 2·4 million tons of fish which amount to only 4 per cent of the total world production, though the potential fish catch from this area is estimated to be at least 4 to 5 times more. The major fishing areas in India today are confined to an offshore belt of 15 kilometres off the south-west coast, whereas the average shelf width is about 50 kilometres, and rich fishing grounds are available even further beyond the continental shelf. Waters which can sustain prawn and tuna have not been fully explored, while little attention has been paid to coastal aquaculture, ie the culture and raising of oysters, clams and mussels. On a rough average, the harvest from the ocean averages about 1·2 kg per hectare in general and about 24 kg per hectare on the continental shelf areas; but in fertilised fish ponds this productivity can be increased by as much as twenty times.

The success of oceanic fishing depends on how well we understand the location of the fish shoals and on the level of sophisticated marine technology in the country. Location, tracking and identification of fish shoals involve two major steps: (1) search for the general area in which commercial concentrations are to be expected, and (2) the localisation and detection of the precise position of the fish. In most advanced countries, the long-range search involves broad-scale mapping with heavy dependence on environmental information and receives much support from satellites, buoy and computers with appropriate sensing equipment. Localisation utilises sonars, odours emitted by fish, and even lasers and is critical with respect to groundfish. But each phase is dependent on basic data provided by biological research. Our fishing fleet consists of about 3,000 mechanised boats with the simplest of gear; compare this with the USA's over 76,000 powered craft (ranging in price from Rs. 7,500 to as much as Rs. 13 million). It is thus clear that given an adequate programme and investment in appropriate hardware, a significant dent can be made on our food resources and nutritional standards by the exploitation of our seas.

Looking for oil

A similar lack of urgency seems evident in our search for alternative energy resources. Take the case of oil. It is established that approximately 20 per cent of world's reserve of oil lie offshore. India herself hopes to find about 115 million tonnes of oil offshore during the next 10 years and has set aside an outlay of Rs. 1,208 crores on the purchase of equipment and foreign consultancy services. Our potential oil provinces lie in the areas of Gulf of Cambay, Bombay High, Indo-Ceylonese Trough, Bay of Bengal and Andaman and Nicobar Islands, and the first offshore well at Aliabet has shown the existence of hydrocarbons in that area. Geophysical surveys, at a cost of about Rs. 7·5 million to demarcate the area for drilling, are now under way in the Bombay High region. The initial investments required for offshore drilling are 4 to 7 times higher than on land, primarily because of the cost of equipment (India has recently bought an offshore

drilling unit at a cost of approximately Rs. 112 million) and the cost of operating in the dangerous and unknown ocean environment. It will take a few years before we can develop the expertise or the equipment necessary for our offshore oil exploration programmes and this only if a planned, concerted research and development effort is mounted now. The fact that India imported crude oil worth Rs. 102 crores in 1970–71 makes this all the more imperative. Moreover, although the existing programme seeks to go only up to 100 metres water depth on the outer shelf, it is becoming clearer that the continental rise and submarine fan sediments lying at much greater depths may hold even a far larger wealth of petroleum resources.

Minerals

The sea water itself is an excellent source of the soluble minerals like salt, potassium, magnesium and bromine. Every cubic kilometre of sea water contains about 40 million tons of dissolved solids which could have a value of more than Rs. 75 billion when extracted. The exploitable mineral deposits are probably primarily the materials of the sediment and chemically formed material at or near the surface, such as ferro-manganese nodules.

TABLE 1

MINERALS IN SEAWATER PER CAPITA FOR 6 BILLION PEOPLE

Mineral	Amount
Water	2×10^8 tons
Salt	6×10^6 tons
Magnesium	2×10^5 tons
Calcium	9×10^4 tons
Potassium	9×10^4 tons
Bromine	1×10^4 tons
Aluminium	200 tons
Manganese	2 tons
Copper	460 lbs
Silver	140 lbs
Gold	3 lbs

TABLE 2

SOME ELEMENTS IN FERRO-MANGANESE NODULES ON THE FLOOR OF THE PACIFIC OCEAN PER CAPITA FOR 6 BILLION PEOPLE

Element	Amount
Manganese	60 tons
Iron	35 tons
Aluminium	7 tons
Nickel	2 tons
Copper	1 ton
Cobalt	1 ton

TABLE 3

VALUE OF PRODUCTION OF GEOLOGICAL RESOURCES FROM THE OCEAN AND THE LAND (IN MILLION DOLLARS)

	Ocean	Land	Total
Oil and gas	3,600	27,500	31,100
Sulphur	25	240	255
Sand and gravel	100	2,000	2,100
Titanium	33	37	70
Zircon	11	0	11
Tin	5	460	465
Diamonds	4	284	288
Monazite	1·5	0·3	1·8
Iron	0·7	5,300	5300·7
Gold	0	1,310	1,310
Phosphorites	0	375	375
Manganese	0	423	423

Productive operations for mining of submarine deposits of tin, diamond, gold and iron in various parts of the world are well known. It is less widely known that the near-shore submarine deposits of sand and gravel are becoming increasingly important sources of construction materials. It has been estimated by M. B. Schoefer that the minerals in seawater are present in large enough quantities to satisfy the potential demand for a number of decades if not centuries, as shown in the tables 1 & 2.

It would be well, however, to point out that only a few of these minerals have any possibility of being economically mined with the present state of technology. In 1964, the total value of sea floor production of these minerals was about Rs. 285 billion, while the value of the same minerals mined on land was Rs. 285 million, only a bit more than half the Rs. 548 billion total production of all minerals on land.

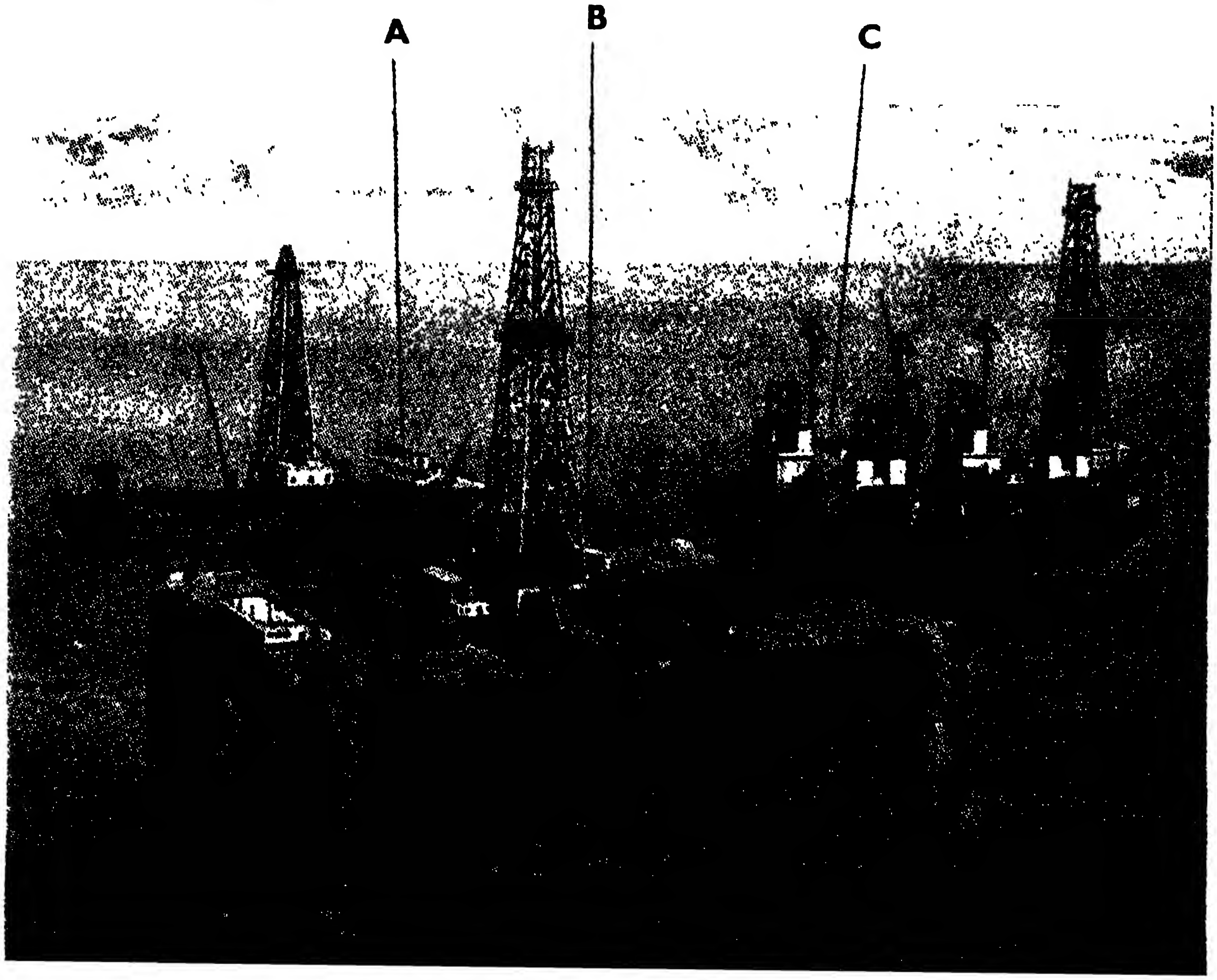
In India, among other physical resources, heavy mineral-rich beach sands containing monazite and ilmenite have been found on Kerala, Tamil Nadu, Maharashtra, Andhra Pradesh and Orissa coasts. Ferro-manganese nodules of 2·5 cm size and appreciable quantities of nickel and cobalt besides 15 to 30 per cent manganese have been sampled from various locations in the deeper parts of the Indian Ocean such as near the foot of the Arabo-Indian ridge and west of it, at 20° S, in the south-east Indian Ocean. Offshore occurrence of calcareous deposits suitable for chemical and cement industries have been reported from bottom samples in Andaman and Nicobar and off Saurashtra, Kerala and Laccadive Islands. These deposits, which represent the remains of calcareous organisms

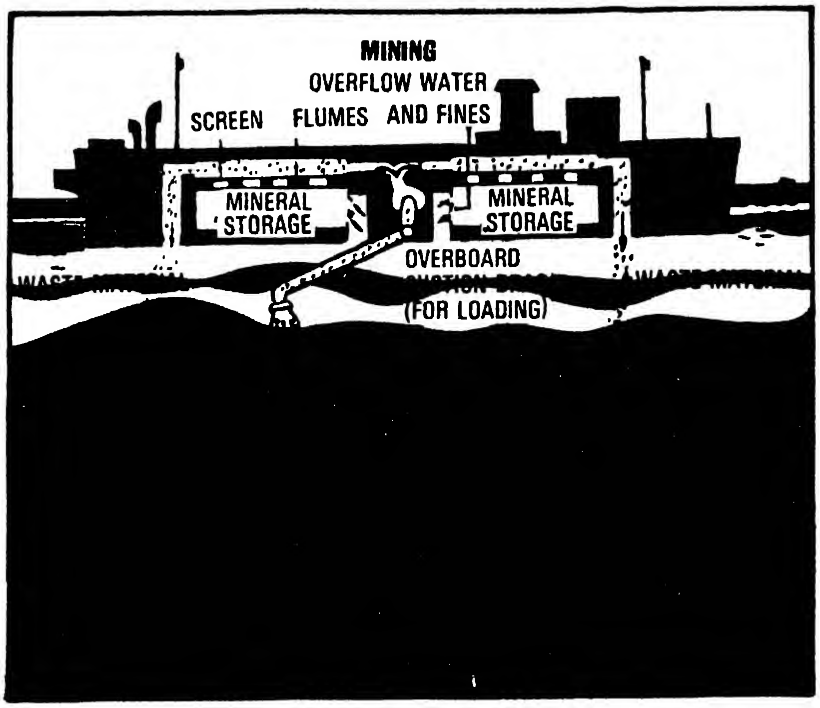
such as corals, are expected to occur in many more areas all around the Indian Peninsula. Phosphate nodules and barium concentrations have also been recorded off the west coast of India and Laccadive Islands while chromite has been found in the sea floor rifts in the Indian Ocean. The efforts to survey the extent of these resources have been few and far between and there has been no effort whatever to exploit these resources.

Further, development of largescale desalination of sea water using nuclear power is progressing rapidly in the world and the development of its technology may become important for the large urban centres near the sea. The Indian Atomic Energy Commission's plan for a similar effort is yet to get off the ground. The sea also has large potential sources of energy in the temperature difference between surface and deeper water and at the surface between areas of upwelling and sinking. Theoretically this could provide 1,000 times the needed power, and one power plant to operate on this principle is under construction in Abidjan in West Africa. Practical utilisation of this power source is not likely to be competitive with other sources at this stage, but this seems a fruitful area for engineering research.

The greatest potential resources for generation of energy are, however, the materials for atomic fission and fusion. It has been estimated (J. D. Issacs, and W. R. Schmitt, 1963 " Resources from the Sea ", *Int. Sc. Tech.*, June 1963, pp. 39–95) that the thorium and uranium in the world's oceans could supply a power requirement for 6 billion people with a per

Three types of drilling rigs: A. DISCOVERER III combines a unique rotating mooring system, a flume stabilisation system and an advanced semi-automated pipe-handling system to give it unmatched deep-water performance. B. Semi-submersible III MARK 2 — longer than a football field and taller than the Astrodome — will be the largest fully self-propelled marine drilling unit ever constructed. C. Offshore MERCURY: the world's first self-propelled, elevating drill ship combines the high mobility of a drill ship with the superior drilling qualities of a self-elevating platform. The second unit has been bought by India and is now being built in Japan

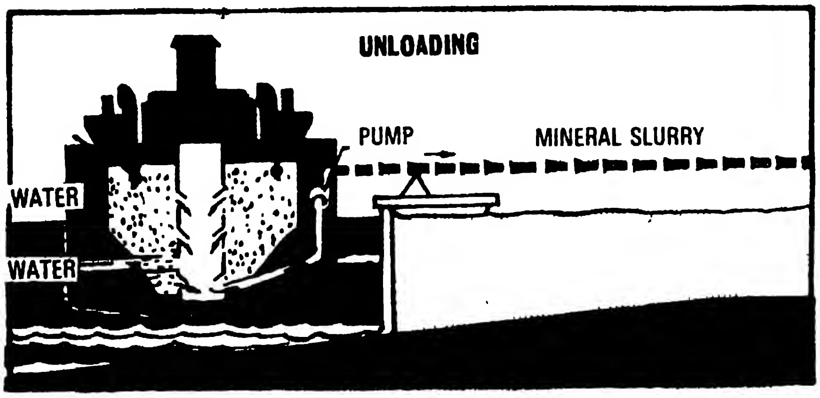


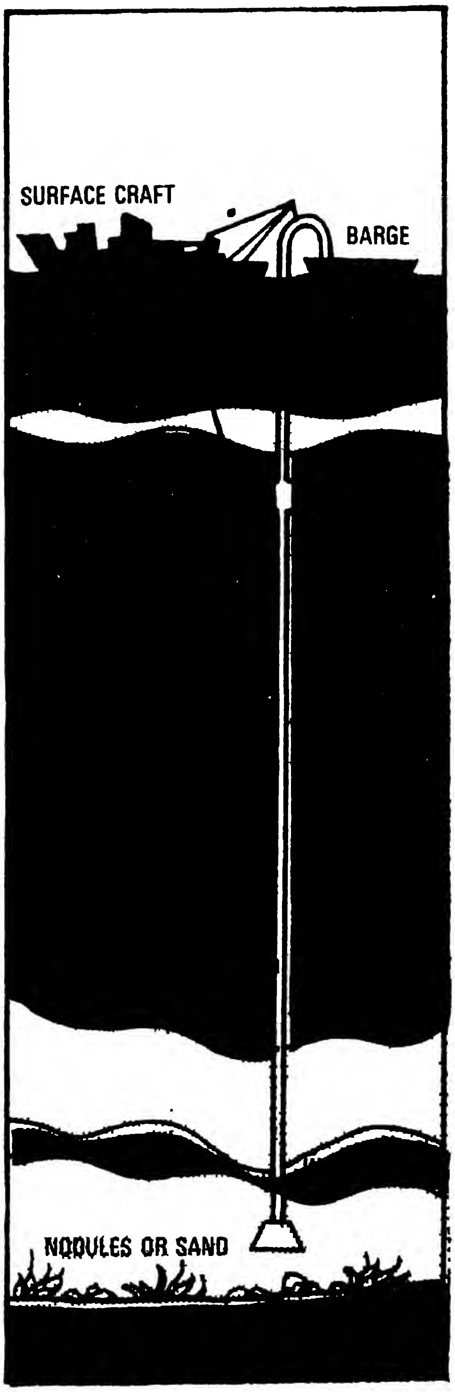


Top: Flow of minerals and waste materials through hopper dredge used in marine mining

Bottom: Offloading minerals from hopper dredge via slurry pipeline

Right: Air lift method of mining marine minerals





capita requirement of 5 kwh per day for some 700,000 years and the deuterium and hydrogen could supply fusion power for times greater than the age of the solar system. Maybe because the land sources are doing alright for the time being, the sea today is used only as an excellent source of cooling water for absorbing waste heat. Till now little effort has been made to develop any extractive technology.

Research activities

In India a large number of organisations have been working in this field of ocean science and engineering for marine resource exploitation for a number of years. The Geological Survey of India is responsible for all investigations pertaining to geological sciences except for exploration and exploitation of oil and natural gas which is under the domain of the

Oil and Natural Gas Commission. The Atomic Energy Commission conducts studies on the deposition and replenishment of the minerals in the coastal regions as well as on the presence and behaviour of radio-active elements. The Tata Institute of Fundamental Research in Bombay has carried out research in chemical oceanography while the India Meteorological Department has done some work in marine meteorological studies. The National Institute of Oceanography, created in 1966, is responsible for carrying out research on the basic aspects of physical, chemical, geological and biological oceanography and also for handling oceanographical data. The Naval Hydrographic Office conducts hydrographic studies while the Central Fisheries Research Institutes are responsible for the work on fisheries development. There are, besides, a large number of institutions dealing with problems of research and exploitation of our living resources. There are also a number of Port Development Authorities as well as Beach Erosion Protection Boards. Some state governments have their own geological departments for carrying out geological surveys and some universities, like those in Andhra and Kerala, are also involved in various coastal studies pertaining to marine geology and biology respectively.

All these organisations and their research efforts were coordinated by the Indian National Committee of Oceanic Research (INCOR), established by the Government of India in 1960, for drawing up a programme for India's participation in the International Indian Ocean Expedition during 1962–65.

The multiplicity of organisations can be explained by the fact that the nation's marine interests are vast, complex and composed of many critical elements. Any worthwhile progress in this field would require a plan for national action and for orderly development of the uses of the sea. The plan must, in general, provide for a determined attack on immediate problems concurrently with initiation of a long-range programme to develop knowledge, technology and a framework of the laws and institutions that will lay the foundation for efficient and productive marine activities in the years ahead. It is clear that the creation of a strong central agency which may be called the Marine Resources Commission, would be necessary if our marine resources are to be effectively explored and exploited. A number of other countries have already started on such ventures.

An urgent need

The arguments for the creation of Marine Resources Commission in India are diverse. In the absence of an articulated national ocean policy or of specific national projects, the efforts of the many institutions in this area tend to be diffused and uncoordinated which could lead to duplication of equipment on the one hand and the non-use of existing equipment on the other. Technology from abroad is imported without effective absorption or development on the basis of its import. Implications of this technology for peripheral areas are generally lost sight of. The scarcity of foreign exchange in individual institutions inhibits import of new technology which in many cases would prove to be far more economical. The paucity of skilled personnel is paradoxically coupled with the non-use of the skills available, mainly because no flexible communications between the organisations exist. Hardware required for carrying out marine research exploration and development calls for substantial outlays. It is thus necessary to purchase equipments which could be utilised by a number of these agencies and to develop an organisational structure which would give all access to these equipments. In some areas it is also necessary to start the development of indigenous technology and equipment. But this development is possible only if there is a coherent long-term plan and an agency which is able to select the areas which would be of optimum use when coupled with the imported technology and equipment.

The research projects too cannot be carefully selected in the absence of a coordinating body. The educational programmes developed in the universities in the past have had very little to do with what is required in the field by the operating and consulting organisations. As this is an area of threshold technology, the challenges implied in working in this area should on the contrary attract the best talent both within the country and outside.

Another major lacuna in our system has been the absence of up-to-date information on various facets of marine technology around the world. Data collection regarding the physical environment needs to be centralised. Analyses of this data and presentation for the benefit of the various user organisations are necessary. Much of the data can be collected by setting up various research projects under the different institutions while a central body

Paying back a debt...

It happened in Bombay during the last week of January: thousands of dead sardines lay rotting around parts of the city's coastline. The stench was more terrible than the sight.

Why did it happen? The answer, inevitably, is pollution. The sardines had come a long way from the waters off Kerala carried by ocean currents. These fish breed only in pollution-free waters and need a lot of dissolved oxygen in the water to survive. They died when they entered the bay waters around the city which happen to be the repository of the city's sewage. When the bay water was analysed, it was found it contained practically zero parts per million of oxygen.

But one could also make pollution work the other way round. The sea also has a great capacity to assimilate wastes due to its large volume and rapid mixing. By diluting the wastes, so that its micro-organisms can break down the organic constituents, it provides an efficient means of waste disposal. But optimum use of the sea for waste disposal for municipalities, power and chemical plants, requires careful management of local environment and understanding of its transport, diffusion and biological degradation. Domestic sewage, with deliberate additions of certain elements or organic compounds, can be used to produce naturally balanced fertilisers for the marine environment; and pollution can be used to actually increase productivity. Obviously, this would require scientific research, good management and careful controls.

could collect the information and make it available to all other organisations.

In this connection it may be well to study in depth the development of offshore technology in France. The French Government set up their committee on marine affairs in 1963 and in 8 years have developed to the extent that they are now offering this technology to a number of other countries including India. A similar pattern could well be developed here.

It is suggested here the organisation of the Marine Resources Commission should follow the setting up of a major task force which would make a comprehensive investigation and study of all aspects of ocean sciences and engineering in order to recommend an overall plan for national oceanographic programme that will meet the present and the future national needs. The National Committee on Science & Technology has already set up a Task Force on Marine Resources since the submission of this article. This Task Force could be a policy-framing group with the specific objectives of:

- Reviewing the known and contemplated needs for natural resources from the marine environment for the next 5–10 years.
- Reviewing the surveys, applied research programmes and ocean engineering projects required to obtain the needed resources from the marine environment and assessing the current and planned ocean-oriented programme for technical soundness, adequacy of scope, balance of content, appropriateness of organisation, funding and management.
- Determining priorities and identifying existing programmes, including educational and technical training, which need to be supported and new programmes which need to be initiated.
- Identifying a few specific project areas like offshore oil and gas, marine metallic and non-metallic minerals, biological and biomedical resources for designation as ' National Projects ' and recommending a plant of government organisations best adapted to support the objectives of the national oceanographic policy and to indicate the expected costs.

This national oceanographic policy could then be coordinated and implemented through the setting up of a Marine Resources Commission. The Commission could be responsible for formulating short-term policies in the field of marine resources and technology, for the preparation of budgets for development of marine technology for each financial year and for obtaining the Government's approval for the implementation of Government policy in all matters concerning marine and ocean technology through appropriate agencies of the Government.

In conclusion, it must be acknowledged that though institutional changes will not, by themselves, lead to success in this endeavour, they would certainly enhance the possibility of significant breakthroughs.

ROUND-UP OF RESEARCH

Analgesia without Drugs

OUR understanding of neural mechanisms of pain perception has been advanced a step further by studies by five American psychologists, Drs. D. J. Mayer, T. L. Wolfe, H. Akil, B. Carder and J. C. Libesking of the Department of Psychology, University of California, Los Angeles, USA. In an article in *Science* (*174*, 1351, 24 December 1971), they show how electrical stimulation at several sites near the base of the brain of rats renders the animals totally unresponsive to pain while leaving responsiveness to other sensory modes relatively unaffected. Their discovery may lead to methods of treating severe pain without drugs.

Several aspects of pain have puzzled neurophysiologists for a long time. There is no special receptor in the body for pain. Psychological factors such as fear can have a profound influence on it. Some kinds of pain, particularly those resulting from damage to nerves, persist in spite of drugs and even after the nerve has been severed. Faced with patients in excruciating pain, neurosurgeons have in the past tried to destroy the part of the brain through which the pain signals must pass but this approach has not been consistently successful. Pain is now thought to be carried by very small nerve fibres which also carry information about touch but it is not clear how these fibres distinguish between touch and pain.

Dr. Mayer and his colleagues used 22 male Sprague-Dawley rats in whom stainless steel electrodes were implanted on either side of the brain. The brains of 10 rats (Group 1) were stimulated twice a second by an alternating current of 60 cycles while for the remaining 12 animals (Group 2) brain stimulation was provided by a constant current. Analgesia tests were conducted by placing the animals in a small chamber with an aperture in the rear through which the tail was drawn. Electric shocks were administered to the tails of Group 1 rats; pressure with needle-nosed pliers was applied to the four limbs and tails of Group 2 rats. Brain stimulation was judged analgesic if shock-elicited reactions were totally absent.

The results indicated that the peripheral field of analgesia was usually restricted to one-half to one-quarter of the body, and painful stimuli afflicted outside this field elicited a normal reaction. The analgesia, in general, outlasted brain stimulation by 30 seconds to 5 minutes. From a number of observations, the American scientists have concluded that analgesia is not due to a deficit in sensory, emotional or attentional mechanisms or to a global motor incapacity.

Brain stimulation attenuates pain by activating a system of nerve cells that functions normally in the blocking of pain, say the researchers. That such a system exists and is capable of being selectively activated is supported by a number of studies concerning the site and mechanism of the analgesic action of morphine. Morphine acts at certain specific sites in the brain, and these sites show at least partial overlapping with those where analgesia results from electrical stimulation. They suggest that it is plausible that the analgesia they observed results from the activation of a system of neurones in the base of the brain; these neurones have an ultimate inhibitory action on sensory transmission in the spinal cord. This supports a theory developed by Drs. R. Melzack and P. D. Wall seven years ago that all sensations from the body reach the brain through the spinal cord, and that it is the organisation of connections between the nerve cells in the spinal cord that forms the basis by which painful stimuli are distinguished from painless ones. Pain occurs when a gate is opened allowing a barrage of signals from the nerves to reach the brain. Dr. Mayer and his colleagues now suggest that they have found a part of the brain from which activity can travel to nerve fibres in the spinal cord and shut this "gate".

Origin of Cosmic Rays

DESPITE 60 years of intense investigations, the origin of cosmic rays still remains a mystery. The question is whether the primary cosmic rays impinging on the top of the Earth's atmosphere originate inside our galaxy — in

violent processes leading to supernovae or pulsars — or in extra-galactic space. Two research reports have now appeared, but they are nowhere near solving the mysteries.

In the first report in *Physical Review Letters* (*27*, 1604, 6 December 1971), four Japanese physicists of the Institute of Nuclear Study, University of Tokyo, have claimed the detection of an extremely energetic primary cosmic ray particle. The energy of this particle, $\sim 4 \times 10^{21}$ eV, is at least 10 times higher than any particle previously detected and nearly a billion times higher than any that can be made artificially. The particle was detected in the Extensive Air Shower Array operated by the Institute.

When a primary cosmic ray of such high energy penetrates the Earth's atmosphere, it interacts with the nitrogen or oxygen atoms present therein, producing a cascade of secondary particles. These secondary particles multiply as they pass through the atmosphere, resulting at sea level in a shower of particles having relatively little energy spread over a very wide area, known as an Extensive Air Shower.

The Japanese scientists, Drs. K. Suga, H. Sakuyama, S. Kawaguchi and T. Hara, estimated the energy of the primary particle from the overall size and the density of energetic particles within the air shower at sea level. They also determined the direction from which this particle came. It was found that this lies close to two known radio sources, the pulsar AP 2015 + 28 within our galaxy and the extra-galactic radio source 3C 409.

In the second report, Drs. R. Speller, T. Thambyahpillai and H. Elliot of the Imperial College of Science and Technology, London University, have studied the problem in terms of cosmic ray isotropy. They think that cosmic rays originating from some universal process outside our galaxy are likely to be isotropically distributed, ie they arrive with equal intensity from all directions. If they come from our galaxy, the distribution is likely to be uneven.

The degree of anisotropy in cosmic rays is being studied by the British scientists since 1960 using muon detectors located at the Holborn underground railway station in London. Their study indicates that there is a small but significant regular variation within a period of 24 hours in the intensity of cosmic rays arriving at the top of the Earth's atmosphere. This means that more cosmic rays are coming from one particular direction relative to the Sun.

They have now reported in *Nature* (*235*, 25, 7 January 1972) a detailed study of the trajectories of cosmic ray particles in the energy range 10^{11} to 10^{12} eV in the interplanetary space and shown that the anisotropy present in the intensity can be interpreted in terms of the known motion of the solar system relative to the general rotation of the galaxy. The best interpretation of their results is that the high energy cosmic rays originate in our galaxy and diffuse through the interstellar magnetic fields until their distribution is practically isotropic. Their results are also compatible with a universal distribution of these particles.

The experiments of the British physicists, perhaps, confirms the most widely held view that most of the cosmic rays, with the exception of extremely energetic ones ($\geqslant 10^{18}$ eV), are produced within our galaxy either in supernovae explosions or in pulsars. The number of particles detected in the energy region 10^{20} eV is still rather small and they have so far given no evidence for a preferred galactic source. Though the Japanese cannot say anything definite on the origin of very energetic cosmic rays at present, their work may stimulate further studies on radio sources and pulsars as sources of high energy cosmic rays.

Human Cancer Virus

THE discovery in human breast cancer cells of a virus closely related to mouse mammary tumour virus by Prof. Spiegelman and his colleagues (see SCIENCE TODAY, p. 13, February 1972) has raised hopes of the possible discovery of human sarcoma and leukaemia viruses, closely related to the well-known mouse leukaemia and sarcoma viruses. Though there had been indications, nobody expected that the discovery of such a virus will come so soon. A group of cancer research workers in the United States, led by Prof. R. M. McAllister of the University of California, has now announced the discovery of a virus that can cause human sarcoma, and describes its properties in *Nature New Biology* (*235*, 3, 5 January 1972).

The virus, known currently as RD 114 virus, has a curious history. More than a year ago, McAllister and his colleagues found a small girl suffering from a skeletal muscle tumour called rhabdomyosarcoma. They established in culture a line of human cells from this tumour, but found no evidence of the production of any cancer viruses. Then they injected the cells

into kittens, four of which developed sarcoma. The cells from the cats' sarcoma had a human chromosome complement. This meant that the girl's sarcoma cells had established themselves in the cat and multiplied to give rise to the tumours. Further, the cells from the cat tumours contained the virus-like RD 114 particles which could not be detected inside cells from the original rhabdomyosarcoma.

Many biologists at that time asked whether RD 114 really originated in the girl's sarcoma cells or it was picked up by the cells after they had been injected into the cat. For the brain tumour of a kitten in which RD 114 virus was detected had been previously infected with feline leukaemia virus. Hence, one obvious possibility was that RD 114 is a cat virus present in the kitten before the inoculation; it entered the human cells later. On the other hand, there is also the possibility that RD 114 virus is of human origin, and was initially latent. Possibly the injection of sarcoma cells into the kitten activated this latent virus.

McAllister and his group seem to have cleared many of these doubts. It has been established that RD 114 particle is a C-type virus. These viruses form a group closely involved in the formation of cancers in chickens, mice, hamsters, cats and some lower primates. To find out to which of these RD 114 belongs, an immunological test was conducted. Sarcoma and leukaemia viruses of lower mammals have been classified into specific groups chiefly on the basis of their antigenicity. For example, all the cat C-type viruses have a group specific antigenicity gs 1 in common which is not present in the corresponding mouse, rat or hamster viruses; each of these has its own unique gs 1 group-specific antigenicity. Further, all the lower mammalian sarcoma and leukaemia viruses share a second antigenicity, the so-called gs 3 or interspecies antigenicity. The tests indicated that RD 114 contained gs 3 antigenicity, but not any of the known gs 1 antigenicities. By elimination, they conclude that the possibility that RD 114 is a human C-type virus is extremely high.

Their conclusion receives support also from the results of the experiments of Drs. E. M. Scolnik, W. P. Parks, G. J. Todaro and S. A. Aaronson reported in *Nature New Biology* (*245*, 35, 12 January 1972). The group has investigated the immunochemical properties of the reverse transcriptase of the RD 114 virus. The reverse transcriptases in the groups of lower mammalian sarcoma and leukaemia viruses are very similar enzymes but are not immunochemically identical. They measured the extent to which the reverse transcriptase from RD 114 virus was inhibited by antisera against the cat and mouse enzymes. It was found that the enzymes from RD 114 virus were not inhibited appreciably by the antiserum. These scientists therefore conclude that RD 114 belongs to a new and immunochemically distinct group, the human C-type viruses.

K. A. Neelakantan

Garlic Kills Mosquitoes

GARLIC, for long used in cooking and folk medicine, may well find a new use — as an insecticide. Two compounds from garlic, namely diallyl disulphide and diallyl trisulphide, can completely destroy mosquito larvae, apart from other crop pests, at 5 ppm concentration. These compounds are likely to be non-toxic to man; being volatile, they also don't leave inconvenient residues.

Garlic has long enjoyed a place in systems of medicine like unani and ayurveda. It has been shown to contain a compound called allicin having antiseptic properties.

The anti-mosquito properties of garlic were discovered by S. V. Amonkar and E. L. Reeves who noticed that wherever an alga called *Chara* grew, there were no mosquitoes around. An extract from *Chara* was found capable of destroying mosquito larvae. The extract had a garlic-like smell; and this led them to see whether garlic would have the same effect. The crude garlic extract, they found, could destroy larvae at 30 ppm concentration.

Because of the importance of garlic in the food industry and in folk medicine, several groups of workers have attempted to study its chemical constituents. Several S-substituted cysteine sulphoxides have been characterised. Some of these are present as gamma glutamyl peptides. However, these compounds are readily broken down by enzymes and also decompose spontaneously to a large number of compounds like alkyl sulphides, sulphoxides and thiols. For example allicin, the anti-bacterial principle, is formed from (+)S-allyl-L-cysteine sulphoxide (alliin) by enzymatic reaction. Alliin itself did not show antimicrobial activity, but when treated with the garlic enzyme (alliinase), allicin was formed. It is for this reason that intact garlic does not possess marked anti-

(*Continued on page 23*)

BLURS & BRIGHT SPOTS

How Not To Say, No!

WHO takes the key decisions at a nation's head? The Head, naturally, one could say. The king, the president or the prime minister. He alone takes the credit, or the blame when things go disastrously wrong. For instance, the abortive Bay of Pigs invasion in Cuba by the US when Kennedy was the President. Or, whatever happened in Pakistan during the last one year. But the head of the government is hardly ever alone in taking decisions. Around him there always is a group of men — all experts in political and military strategy and highly intelligent — who form the inner core of policy-makers. Yet errors are made that put the nation in the dock. Mistakes are repeated. And the rest of the world echoes what President Kennedy had said after the Bay of Pigs: "How could we have been so stupid?"

Group stupidity is not the correct explanation. You may call it GROUPTHINK, as Irving L. Janis does in a recent issue of *Psychology Today*. He is a Yale University psychologist who has specialised in the study of psychological stress and persuasion in decision-making. His Law of Groupthink (a la Parkinson) runs like this: *The more amiability and espirit de corps there is among the members of a policy-making ingroup, the greater the danger that independent critical thinking will be replaced by groupthink, which is likely to result in irrational and dehumanising actions directed against outgroups.*

How is it possible for a group of people with individual minds and critical faculties to be unanimous in decisions that would apparently spell disaster or violate the principles of humanism and morality? Is there never a dissenter, a critic or one who would beg to differ? Maybe there often is, but he chooses to soften his own doubts and fall in line. Professor Janis has found eight symptoms that explains the why:

1. *Invulnerability:* Most or all members of an ingroup share an *illusion* of invulnerability, which leads to overoptimism and taking of extraordinary risks. Despite warnings, dangers seem unreal. This illusion, Prof. Janis says, led to the belief that the CIA plan for Bay of Pigs would succeed two hundred per cent. Or in the case of Viet Nam, as Bill Moyers, member of President Johnson's ingroup, the "Tuesday Cabinet", had said, "the belief that if we indicated a willingness to use our power, they (the North Vietnamese) would get the message and back away from an all-out confrontation".

2. *Rationale:* Groupthink victims not only ignore warnings, but tend to invent rationalisations to discount the warnings. This had happened before the Japanese attack on Pearl Harbour on 7 December 1941, when US planners had convinced themselves that Japan was too tiny to risk a full war against the US. It also happened during the days the Viet Nam War was being escalated by the Johnson ingroup despite contra-indicatory results. Before the bombings began in 1964, the planners argued that six weeks of bombing would bring the North Vietnamese to their knees. "What if it doesn't?" somebody had asked. Then four more weeks, maybe, the others said.

3. *Morality:* Groupthink victims refuse to believe that they as a group can do anything immoral. It is known at least two influential members of President Kennedy's ingroups had serious doubts about the Bay of Pigs plan and had presented memos to that effect, but remained silent when the group meeting was held.

4. *Stereotypes:* The leaders of enemy groups are taken as stereotypes and hence assumptions made about what they would and wouldn't do. Kennedy's groupthinkers believed Castro was so weak both politically and militarily that he would not be able to resist the assault by a small group of exiles. Or the crudest sloganistic domino-theory stereotype used by Johnson's group (" If we don't stop the Reds in South Viet Nam, tomorrow they will be in Hawaii and next week they will be in San Francisco ") that had become so firmly rooted that it blunted every other more sophisticated reasoning.

5. *Pressure:* Groupthinkers apply direct pressure to any individual who tends to express doubts about any of the group's shared illusions. The pressures could range from mere plea to open taunt to bypassing the doubter during vote-taking.

6. *Self-censorship:* Group loyalty and consensus-seeking norm activate this aspect whereby the deviationist will either fall in line silently or minimise the edge of his doubts. Remember the two doubters in the Bay of Pigs discussions!

7. *Unanimity:* Groupthinkers carry an illusion of unanimity within the group. This stems partly from self-censorship and the resulting silence on the part of a member is taken as a sign of approval. When most tend to agree, the dissenter is more likely to question his own doubts rather than the group's judgment. There is also the secret fear that once unanimity is shattered, the need for critical thinking may make their job impossible. " Our meetings took place in a curious atmosphere of assumed consensus ", wrote Arthur Schlesinger (one of the Kennedy aides) in *A Thousand Days.*

8. *Mindguards:* These are the persuaders, the self-appointed protectors of the leader and fellow members from adverse information that might break the complacency they shared about the effectiveness and morality of past decisions. Arthur Schlesinger's opposition to the Bay of Pigs plan elicited this remark from Robert F. Kennedy who was then Attorney-General: " You may be right or you may be wrong, but the President has made his mind up. Don't push it any further. Now is the time for everyone to help him all they can."

If that's really how a nation's (hence the world's too) destiny is shaped, which indeed it is if Jack Anderson's recent columns are to be believed, it is time the world paused and listened to its heartbeats. ■•■

Round-up of Research

(Continued from p. 21)

bacterial properties but when crushed, the enzymes are released, which act on alliin to give allicin. The larvicidal principles are also produced by enzymatic reaction.

In studies by the author and S. V. Amonkar (Bhabha Atomic Research Centre, Bombay), fresh garlic was homogenised in the presence of water so that enzymes could react with the substrates. The extraction was carried out with solvents of increasing polarities. The active principle was located in the light petroleum extract. The active fraction was purified using column chromatography and a colourless liquid having high larvicidal activity and a garlic-like smell was isolated. This oil was steam volatile and could also be obtained by steam-distillation of crushed garlic. Further purification was done by column chromatography. The active components were characterised as diallyl disulphide and diallyl trisulphide. Both the compounds show high larvicidal properties.

For the evaluation of larvicidal properties, mosquito larvae (*Culex pipiens quinquefasciatus* Say.) were treated with the emulsified solution of the test samples. Mortality was scored after 24 hours, and the active principles showed 100 per cent of 5 ppm level. Diallyl di- and trisulphides were also observed to be antagonistic to several insect pests like potato tuber moth, red cotton bug, red palm weevil and houseflies when these were exposed to the vapours of the active principles. Since garlic has been used in cooking for long without any adverse effects, it is likely to be non-toxic to man at the effective levels. Also, these compounds and their decomposition products are comparatively volatile and will not pollute the environment by residual effects. These properties suggest that diallyl disulphide and diallyl trisulphide may have some potential value in the control of insects.

These are two simple organic compounds and can be prepared very easily. The synthetic samples compared well with the natural samples in larvicidal activity.

It is interesting to note that the compounds diallyl sulphide, dipropyl di- and trisulphide, which are so closely related to the active principles, did not show appreciable larvicidal activity even at 200 ppm.

A. Banerji

[Dr. Banerji is with the Bio-organic Division of the Bhabha Atomic Research Centre, Bombay.]

GROWING PADDY ON CEMENT BEDS

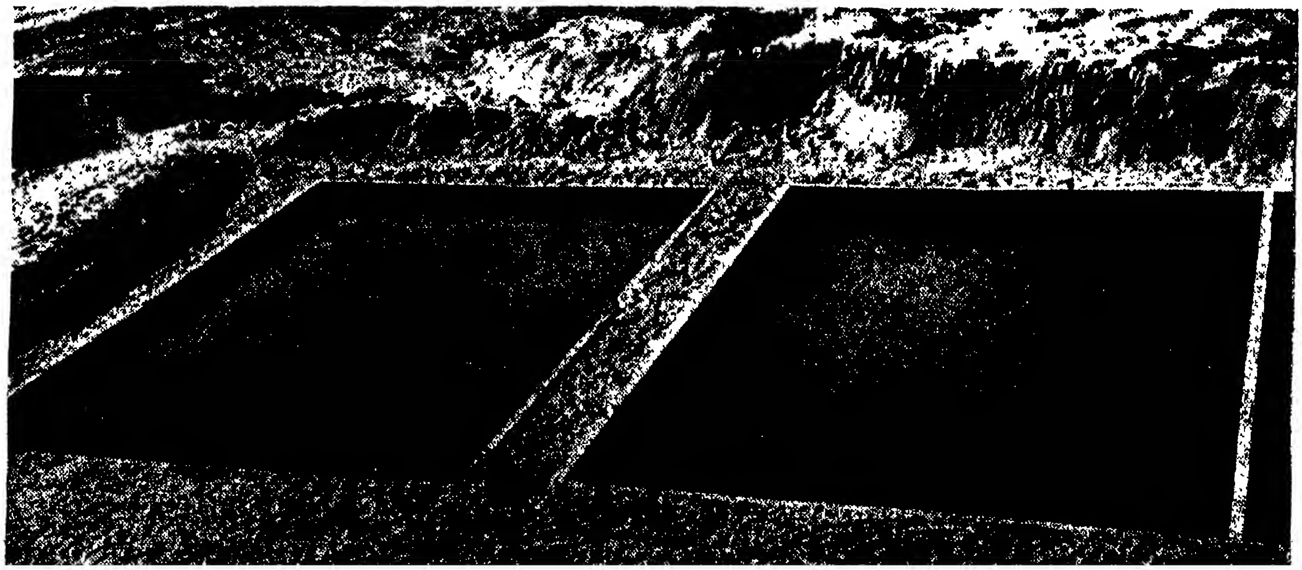
IN Kerala, a landlord tried a novel experiment. He cultivated a crop of paddy on the terrace of his house. Sure enough, he reaped an excellent harvest. There are many such enthusiasts, some of whom even grow paddy in flower pots. Which all goes to show that the cultivation of paddy and other crops that do not have deep-going roots and that depend on rain or an abundant water supply can well be done on an impervious floor with just a 30-centimetre layer of soil. The impervious floor, of course, prevents the loss of water by percolation and also prevents the leaching of manure.

Experiments in this type of farming have been tried. In the US Taiwan and South Africa asphalt strips were laid 0·6 metres below the surface and crops were cultivated (see SCIENCE TODAY, p. 13, August 1971). In India, several such experiments have been under way in Tirunelveli district in Tamil Nadu. In Udangudi Block in this district, farmers removed sand up to a depth of about 45 centimetres. They then laid a concrete floor, making use of the stone chips that abound in the region. (These stone chips mixed with lime and cement gave a crude concrete). The concrete was rammed in to form an impervious flooring and a parapet wall of stone and brick in cement mortar was built around to compartmentalise the area and also to retain the water used in cultivation. The sand was refilled with some additional loamy or silty soil. (Silt was obtained from the tank-beds in the vicinity). The plot was levelled, manured and then cultivated with paddy. Water from a well excavated nearby was led to the beds in open channels. Farmers were thus able to raise three crops a year.

But stone chips may not be readily available everywhere. There is an alternative, however — soil cement. The Cement Service Bureau at Madras carried out a series of experiments to get an optimum thickness of soil cement layer and the percentage of cement to be mixed.

To start with, an experiment was conducted in the Bureau's office itself. The soil conditions of the coastal area were simulated here. A plot 25 × 25 cm was excavated to a depth of about 0·6 metres and a 15 cm layer of sand from the sea coast near Tiruvanmiyur was filled in. Edge walls were built around the plot with brick in cement mortar and plastered inside. About 7·5 cm of excavated earth was rammed over the sand using a quantity of water to obtain a fairly hard surface. Soil cement, using five per cent cement by weight, was spread in a uniform thickness of 5 cm over this and compacted with optimum moisture content. After the cement had set, a neat slurry, using two kilograms of cement mixed with water to obtain a creamy consistency, was brushed over the surface to seal the pores. Water was then impounded in the bed and the level marked on the side wall. Subsequent measurements each

Two of the experimental beds at Besant Nagar showing the soil cement floor, ready for refilling



Experimental paddy cultivation in Besant Nagar area near the Adyar sea coast

morning and evening ascertained the loss of water through evaporation and percolation. A sump provided at the edge of the plot, 0·3 metre below the sand layer, recorded the percolation of water, if any. The level of water fell by about 0·6 cm per day. This was due to evaporation as there was no evident percolation. Earth was then filled in the bed and paddy seedlings planted. Of course, the crop thrived well.

Later, largescale experiments were started near the sea coast itself at Besant Nagar. Four beds of 9 × 6 metres each were prepared. One was subdivided into four rectangles. Seven different specifications were tried with variations in the thicknesses of rammed earth and soil cement and in the cement contents of the slurry seal. From this it was found that a 2·5 cm thick soil cement layer compacted over a 7·5 cm thick layer of rammed earth was an adequate " water-saving floor ".

Different strains of paddy were cultivated with successful results. The approximate cost of providing the impervious floor only with soil cement works out to about Rs. 2,000 to Rs. 2,500. The additional costs of excavating the sandy soil and replacing it with silt and the provision of water, etc will, however, vary with local conditions.

The greatest promise for this technique lies in the vast deserts of Rajasthan and the rocky tracts that stretch across large areas of the country.

K. K. Nambiar

[K. K. Nambiar is Chief Engineer at the Cement Service Bureau at Madras.]

BRAIN TEASERS

Fortune hunting

In a certain village there lived an old man. One day he called his eldest son to him. He dug out his carefully hoarded life-savings and they counted it. There was the incredible sum of Rs. 20,000. So he gave his son part of the money and told him to seek his fortune and come back after a year. The son went to the nearby city and a year later came back with twice the amount his father had given him. The father was, of course, pleased. He called his second son to him. After taking some money from his eldest son's fortune he gave the rest to the second son and told him to seek his fortune. Sure enough the second son too came back after a year, but this time with thrice the amount given to him. The father was again pleased. He now called his youngest son. Taking out part of the second son's fortune the father gave the rest to his youngest son and sent him away. And the youngest brought back four times the amount given to him. This time the father kept all the money. Now if each son had brought back an identical sum of money, how much of his Rs. 20,000 did the father give his first son? (Remember the answer should be only a round figure in thousands only — not in fractions of thousands).

Small coins, big coins

It was month-ending time in the temple. The priests examined the Hundi (the place where devotees place their offerings to God) to find out how much the temple income for the month was. Alas, there were only coins. Coins of all denominations from one paisa to one rupee. Scores and scores of them — 216 to be exact. And when they counted the coins they found they had a handsome total of Rs. 136·64. The temple trustee, an amateur mathematician, noticed a strange fact. He found a peculiar relationship between the denomination of coins and the number of coins in that particular denomination. Can you figure out what this relationship was? (Remember — no old anna coins, etc were in the collection).

G. A. D. Prasad

(Solutions next month)

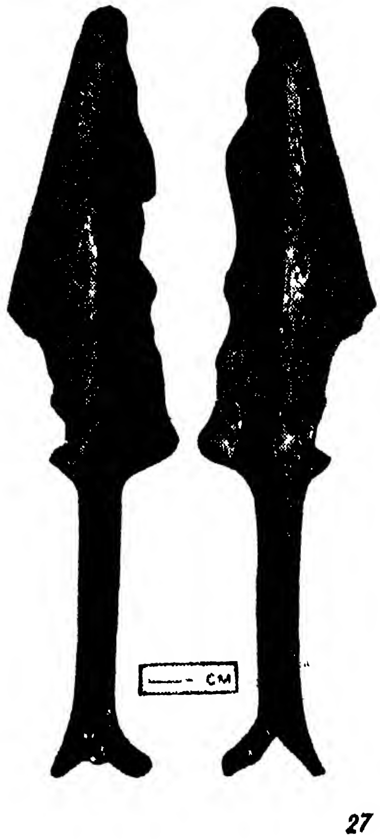
[See p. 63 for solutions to last month's Brain Teasers].

The first signs of economic development and urbanisation in Indian history appear with the extensive use of copper tools by some of the ancient cultures. Recent studies show they knew some advanced metallurgical techniques. Did they smelt copper ? What techniques did they use, and what was their origin ? Why did some of them flourish while others did not ? And finally, how did they decline ?

Not only does technology spur economic growth but it also sets the pace for social changes. Together with ecology — the environment and all the living beings in it — it shapes the way of life of a particular people. The tools and technology a culture used and its ecology can thus indicate its way of life.

To the archaeologist, therefore, these are of immense value. They help him in studying the causes and course of social changes. But it needs a new approach where the chemist, geologist, zoologist, botanist, anthropologist and the archaeologist work together. Though barely begun, such studies have shed some new light on our ancient cultures, and have also raised some controversies. The first article here discusses their metallurgical techniques while the second traces their growth and decline in the context of their entire milieu

HOW ANCIENT WAS ANCIENT INDIA?



Bronze axes excavated from Navdatoli, Madhya Pradesh (above)

Two sides of a dagger-blade with antennae hilt (antennae sword) — one of the remarkable copper implements excavated from Chandoli in the Deccan (right)

Metallurgy in Ancient India

K. T. M. HEGDE

THE Neolithic communities were the earliest to use metal objects. They were the first peasant communities, dating, in Western Asia, from 7 millennium BC. Their metal objects consisted of small fish hooks and pins forged from native metals. The later Chalcolithic cultures knew how to extract metal from ores. The term Chalcolithic is derived from two Greek words, *chalcos* and *lithos*; they mean copper and stone, respectively. The Chalcolithics used copper and stone as raw materials in making tools and weapons. As such, they occupy an important position in Indian archaeology. They date from the pre-Harappan times, 2500 BC to 1000 BC, and were very widely distributed in northern, western and central India and the Deccan Plateau.

The pre-Harappans did not use metal tools so extensively, though they did use metal. But a large number of copper artefacts were found in the Harappan settlements, mainly in Harappa and Mohenjodaro. These included razors, knives, axes, arrowheads, pins, etc. They show that the metallurgical technology employed in their production was much advanced. We cannot, however, ascertain whether these artefacts were imported or made locally. These objects are similar to the objects excavated at Susa and Anu, the contemporary Persian sites. On the basis of this evidence, Sir John Marshall, the excavator of Harappa and Mohenjodaro, observed that these artefacts were probably imported from Persia. Recent excavations at Tal-i-Iblis in the Mashiz Valley in Iran have revealed evidence of continuous copper smelting operations and a flourishing copper smiths' trade there dating from 4000 BC to 2000 BC. Considering this and the fact that the Harappan settlements had trade relations with West Asia, it is possible to observe that the copper artefacts of the pre-Harappan and Harappan settlements were probably imported. However, based on recent studies, some researchers conclude that the Harappans knew copper smelting and some advanced metallurgical techniques (see box).

The post-Harappan Chalcolithic cultures settled in western and central India and the Deccan in the first and second millennium BC. These were small peasant settlements, unlike the urban settlements of Harappa or Mohenjodaro. But like the Harappans, these communities also used copper and stone as raw materials. Over a score of these sites have been excavated during the last 15 years. In 1963, Prof. H. D. Sankalia of Deccan College, Poona, leading an excavation of the Chalcolithic site at Ahar near Udaipur in Rajasthan, discovered heaps of semi-fused glass-like material together with copper tools. On analysis, at the Archaeology Department of the M. S. University, Baroda,

---

THE Harappans smelted copper, though they did not invent the technique. Recent studies show that they also knew several advanced techniques of alloying and closed casting.

Mesopotamian records belonging to the third millennium BC show that there were trade relations between West Asia and the Indus region and that copper was imported from "Meluhha" in the Indus region. Large quantities of copper ore were recovered from a brick-lined pit in Mohenjodaro during excavations. These indicate that the Harappans probably used copper ores. Recent spectroscopic analyses at the Tata Institute of Fundamental Research, Bombay, revealed a similarity in impurity patterns between the Harappan tools and the Khetri copper ores. Earlier, studies at the Archaeology Department of The M.S. University, Baroda, had shown a close similarity in impurity patterns between Khetri ores and the Ahar tools used by the Chalcolithics. All these suggest, according to Dr. D. P. Agrawal of TIFR, that the Harappans too used the Khetri copper ores. Besides, he argues, without having an abundant source of copper ore the Harappans could not have developed a sophisticated metallurgical technology and forged so many tools.

How advanced was the Harappan technology? Studies suggest they knew alloying. Of the 175 copper tool samples analysed, 70 per cent were of pure copper, 10 per cent contained less than 8 per cent tin, 14 per cent had 8 to 12 per cent tin (this is the optimum alloying combination for bronze) and 6 per cent included over 12 per cent tin. Probably they could not "control the optimum range either due to the lack of knowledge or difficulties of correct mixing". And, maybe, tin was too scarce for proper alloying. Though about 20 artefacts contained 1 to 6 per cent arsenic, data are inadequate to draw any definite conclusions on arsenic alloying.

Razors (some double-edged), blades with curved ends, chisels with broad rectangular tangs

and narrow blades, barbed fish hooks, arrowheads with backward-projecting barbs are some of the distinctive Harappan tools. Particularly so are the fish hooks which indicate fine craftsmanship. A saw with unidirectional teeth and tubular drills are perhaps the earliest of such tools in the world. Most of the other tools such as axes, knives, spearheads are of a simple, flat type.

Pots and pans were made by hammering, probably using worn pebbles (steel hammers are used in modern technology). In "sinking", hammering was done over a shallow concave depression cut into a wooden anvil. In "raising", the vessel was kept over a dome-headed stake and beaten from outside. Some of the vessels still bear distinct stake and hammer marks. Wires were made by beating; there is no evidence of wire-drawing. Razors, knives, etc were made by chiselling out from copper sheets.

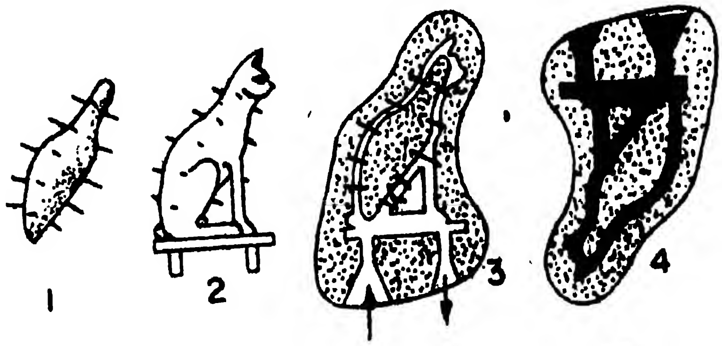
The Harappans knew casting techniques but probably did not maintain a standard as indicated

Harappan techniques

by the puckered surfaces and large blowholes in several axes. And though they knew closed casting, and probably also the addition of lead and arsenic to copper to facilitate casting, they preferred open-mould casting, for most of the implements are flat. However, metallographic analyses show that the cast metal was cooled slowly under control. More interesting, the fine dancing bronze figurines excavated at Mohenjodaro indicate that they were made using the lost wax *(cire-perdue)* casting techniques (see drawing).

Metallographic analyses of the metal grains and surfaces show that cold-working (hammering done on cold cast metal to increase its hardness) and annealing (heating the cold-worked metal to regain its malleability) were practised. Polygonal grains with twins indicate this. Did they know

Casting by the lost wax (*cire-perdue*) method. The wax model (2) of the sculpture is prepared over a clay core (1). The model is again covered with thick clay (3) bearing two holes as inlet and outlet for molten metal. The mould is upturned and filled with molten metal (4). The liquid wax comes out of the outlet as also the surplus metal. The mould is broken when the metal solidifies



soldering? It is thought they knew gold and silver soldering but not copper. Copper parts were joined by riveting or by pouring molten bronze over the parts (" running on ").

However, such an advanced technology, lacking in the pre-Harappans, appears suddenly among the Harappans without going through the various stages of development. This would suggest that the technology did not originate in the Indus Valley. How do we then explain the sudden development? A sophisticated technology was observed in West Asian cultures about 1,500 years older than the Harappan. The West Asians had trade relations with the East. There is also an eastward shift of this technology from West Asia, and the technology is progressively younger en route. Besides, the tools were more or less of the same type as found at the earlier West Asian sites. All this would suggest that the Indus Valley derived its metallurgical technology from West Asia.

the material was found to be copper metallurgical slag.

This identification was significant; it gave evidence of copper smelting. Ahar, therefore, was probably a Chalcolithic copper smelting centre. And probably one of the many such centres, for more than 50 Ahar ware sites have now been discovered in the Aravalli region of Rajasthan. This also led to an important observation: probably the post-Harappan Chalcolithic copper artefacts were indigenously produced.

How do we probe this possibility? For this, it was necessary to link the copper artefacts with Indian copper ore deposits, and find the source of the metal. Ancient metal objects contain a large number of elements, some of them in minute traces, as impurities. These could not have been deliberately fused into the metal. The impurities must have got into the metal from the ore from which the metal was extracted. These impurities, therefore, can serve as clues in tracing the source of the metal. Spectrometric analyses (where the samples are exposed to a light source and the spectrum they emit analysed for their composition) of the artefact samples reveal their impurity

patterns. These can be compared with the impurity patterns of the likely ore samples and the source of the metal can be determined.

In areas inhabited by the Chalcolithic cultures, extensive copper ore deposits are located in the Aravallis. These deposits are also dotted with deep shafts and vast slag heaps — possible marks of ancient mining and metallurgical activities. Aravalli copper ore deposits were therefore considered the likely source used by the Chalcolithic metal smelters. Spectrometric studies were again carried out on these ore samples and on samples cut from representative artefacts from the Chalcolithic settlements excavated at Somnath and Langhnaj in Gujarat, Ahar in Rajasthan, Navdatoli in Madhya Pradesh and Chandoli in the Deccan. Impurity patterns of these artefacts and the ore samples were found to be in close agreement. From this study, we may observe that Aravalli copper ores were exploited as early as the post-Harappan Chalcolithic period, about 1,800 BC, the radiocarbon date of the lowest Chalcolithic level at Ahar.

It was now interesting to know more about the metallurgy of the period, the purity of the metal extracted, whether it was alloyed and how the implements were produced, etc.

Analyses of artefact samples indicated that the copper metal extracted was 92 to 98 per cent pure. Some of the objects were made of bronze, with a tin content of 3 to 12 per cent. Bronze is much harder and stronger than copper. It also gives a harder, keener and more enduring cutting edge. Besides, alloying helps in casting and forging. So the Chalcolithic coppersmiths knew the advantages of alloying copper with tin. But the fact that there were only a small number of bronze objects suggests that tin was probably scarce.

Metallographic examination of artefact samples revealed that the axes were cast. But their cutting edges were not entirely a feature of the casting moulds. The edges were bevelled by hot and cold forging. Some of the axes were cast in unventilated moulds. Axes recovered from Somnath and Navdatoli were, however, cast in well-ventilated moulds. Proper ventilation is essential for good casting of copper and bronze. Some of the objects were produced entirely by forging. A chisel recovered from Navdatoli and a knife recovered from Langhnaj were found to be shaped by hot forging above 500°C, the recrystallisation temperature of copper. ■■

The Rise and Fall of the Copper-Bronze Cultures

TOGETHER with environment, the tools and the technology used by different cultures give us important clues on why a particular group flourished and others did not. Of course, to gather enough evidence in such studies is hard for lack of adequate samples. Based on available data, several groups of researchers have tried to work out the process of social development and urbanisation during the Copper Age in India. Recently, a multi-disciplinary approach has been used by Dr. D. P. Agrawal of the Tata Institute of Fundamental Research, Bombay, in reconstructing the development and the decline of the early Indian cultures in his book *The Copper-Bronze Age in India*.

The pre-Harappans did not use much metal. The Harappans, who flourished in the Rajasthan, Sind and Punjab areas of the Indus Valley between 2400 BC and 1700 BC, were quite advanced in the use of metals. Excavations at Mohenjodaro and Harappa show that they built planned cities with roads, granaries, etc; there were trade and transport and other economic and industrial activities. Houses were built of burnt bricks.

The other ancient copper-using people belonged to the Chalcolithics of south-eastern Rajasthan and the Deccan Plateau dating from 2000 BC to 800 BC and the Copper Hoards (called so because copper implements were found in hoards) of the Indo-Gangetic plains of Doab across Uttar Pradesh, Bihar and Orissa. Though both used copper tools, neither employed a technology as advanced as that of the Harappans. The Copper Hoards, though, were rich in the metal and had their distinctive tools — the harpoon, the anthropomorph and the antennae sword (see page 31) adapted for a hunting nomadic life. No copper vessels were recovered, nor did they seem to have used techniques such as cold-working or annealing. The ridges on their axes, and harpoons indicate the use of closed casting but

alloying was not known. On the other hand, the Chalcolithic cultures knew annealing and cold-working but used only open moulds for casting. In the large number of simple tools they used, there was nothing that distinguished them from other cultures.

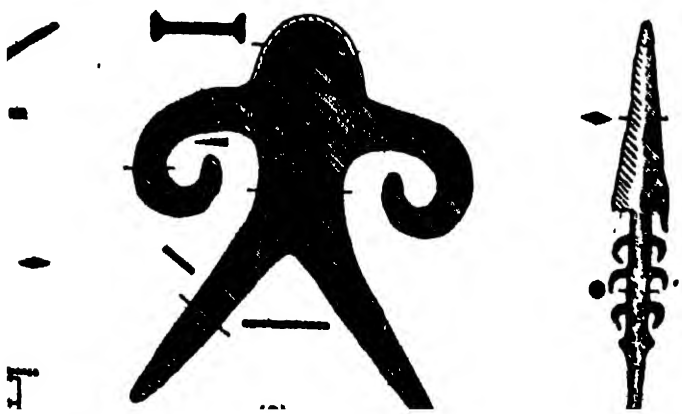
Why was the Harappan technology more advanced than that of the other protohistoric cultures? Why did only the Harappans develop into the urbanisation stage? This is where ecological factors come in.

For a long time it was thought that the Indus Valley, the home of the Harappans, had a heavy rainfall during the period resulting in tropical forests. The Harappan seals depicted animals like the rhinoceros, water-buffalo, tiger, elephant, etc. This led the British archaeologist R. E. M. Wheeler to suggest that these animals infested broad jungles and intermittent marshes. Earlier, S. Piggot, another British archaeologist, had inferred from the extant fauna, the wood needed to burn the bricks used in the Harappan towns, the flourishing agriculture and the elaborate drainage system that the area had dense forests with a heavy rainfall.

The theory was, however, refuted later. W. A. Fairservis, UK, noted that the area had gallery or open forests, instead of thick forests, with trees like babool, tamarisk, kandi, sissu, etc. These forests, which were fed by flood waters rather than by rain waters, also provided the fuel for burning bricks as is done even today. Even at a low rate of burning, these woods give a large amount of heat.

Further, analyses of wood remains do not indicate a moist tropical forest. It was also shown that timber like the pine and deodar used for house construction was brought from considerable distances. This suggested "a vegetation of scrub forest with tall grass and pockets of marshy land at or near Harappa". Such grasslands and open forests are also the habitats of the fauna found in Harappa. All this show that the Harappan culture grew in a dry climate as prevails in the area today. Punjab and Sind have an annual rainfall of about 25 to 50 cm; it is much less in lower Sind. The Indus valley has soft easily cultivable alluvial plains which could be tilled with little effort using simple wooden or copper hoes.

The three distinctive tool types of the Doab Zone Copper Hoards: antennae sword (left), anthropomorph with hammered top (centre) and harpoon (right)



For any social progress, a society should first meet its basic needs. Many researchers think that favourable ecological conditions including an easily cultivable fertile land not only gave the Harappans enough food but an agricultural surplus too; this surplus became the springboard for further progress — better tools for agriculture and industry, transport, urbanisation and technological development. The metal technicians, having been provided for by the society, turned to making sophisticated tools. Discovery of new mines at the same time perhaps led to a sudden and rapid progress, and to more trade and urbanisation. Thus several factors — metallurgy, an abundant supply of copper ores and optimum ecological conditions — interacted in ushering in urbanisation in a prosperous rural society.

The Doab, the home of the Copper Hoards in the Indo-Gangetic plains, in contrast, was a dense monsoonal forest. In an environment rich in game and fish, the Copper Hoards took to a hunting, nomadic life; and the harpoon, the anthropomorph (though it looked like a human figure, it was used as a missile) and the antennae sword became their main tools. Since they could not clear the forests for farming using their simple copper tools, extensive agriculture was not possible, at least, many think, till the Iron Age later provided better tools. Lack of any social surplus thus stunted their technological growth. And the Copper Hoards did not have specialised craftsmen. Whatever tools they used were probably made by itinerant smiths. Also, the absence of metal pots and pans, and permanent settlements shows that they lived a nomadic life.

The Chalcolithic cultures of Central India too were similarly inhibited by ecological factors. The sticky black soil needed heavy iron ploughshares for farming. And this they lacked, having neither the mines nor the technology. Using simple copper tools, they perhaps farmed only the thin alluvial strips. Lack of an agricultural surplus meant that men were not free to follow special crafts and technology. The culture thus remained confined to villages on a simple agrarian economy.

How did an advanced culture like the Harappans decline? Did ecology play a role in this?

In 1964, R. L. Raikes, an Italian hydrologist, said the Harappans declined because of the impounding of the Indus waters by dams thrown up by mud eruptions from earthquakes. While studying the flood problem at the Mohenjodaro site, Raikes and G. F. Dales, US, found water-deposited material and mud-brick fillings at various levels above the flood plain and silty clay below. The silty clay, Raikes assumed, was deposited by still, impounded waters. Certain geological features occurring at the site (pliocene and miocene rocks with a strike-slip fault, sulphur springs, etc) had been shown to be associated with earthquake-caused mud eruptions. A single eruption or a series of them created a wide (about 16 kms is assumed) and highly permeable barrier across the Indus. While letting most of the water flow through, it retained all the solids transported by the river. The silt built up, " and Mohenjodaro, and inevitably all other sites in the area, were gradually engulfed by mud ". And for a period during this siltation, the sites would have been deep under the impounded water; shallow water, anyway, would have remained for a long time till the siltation was complete. Raikes worked out the time for such a complete siltation at 100 years. Based on the several levels of silt and constructions found in the area, five such cycles were proposed. " The silt or mud rose at an average of 5 to 22 cm a year. At this rate those determined to stay would have needed to raise their house levels only every so many years while those who became disheartened may have abandoned their property." The massive mud-brick platforms and fired bricks suggest that some did take precautions. And where the owners did not erect such platforms, the city was gradually buried.

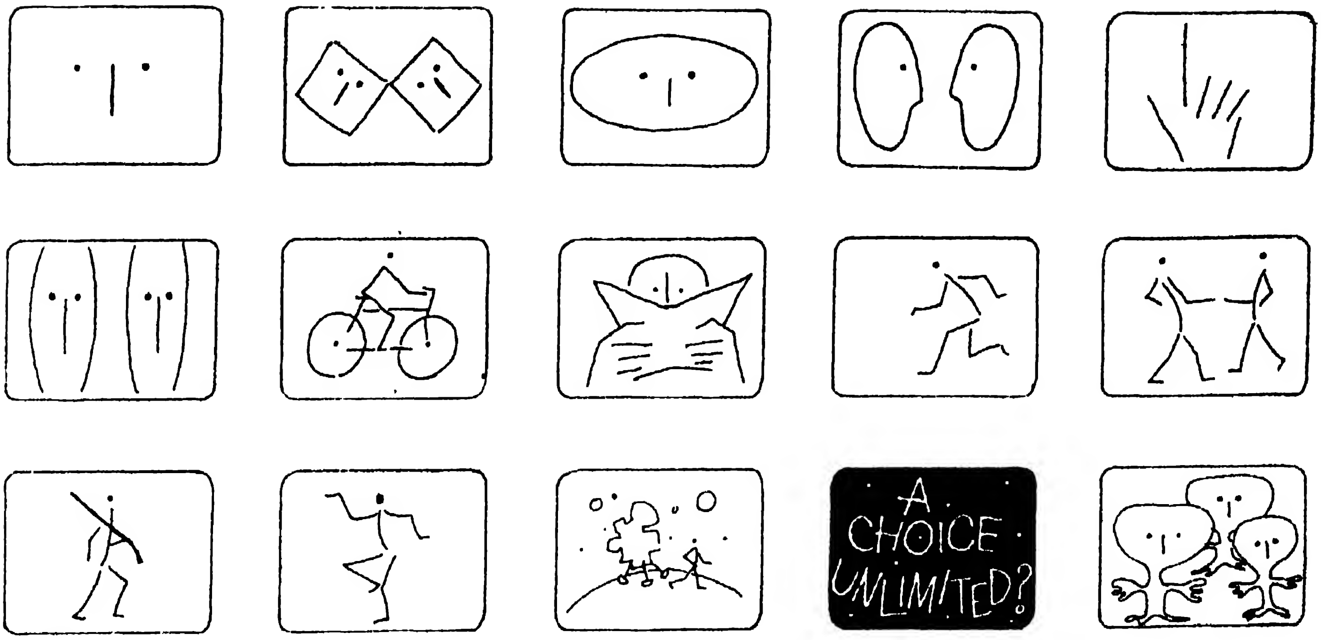
The theory raises certain questions. With an advanced technology, why didn't the Harappans break the sand dam? Did they have to wade through water during the long periods of siltation? The sites being under water, transport would have been difficult. Crops and vegetation would have been affected. And so would be the fauna. Would any culture flourish, as did the Harappans, under such conditions? According to Dr. Agrawal, this is highly unlikely. And Raikes's hypothesis, while seeking to " explain the end of the Harappans, puts their very existence in jeopardy. More work is needed to substantiate this theory."

Another archaeologist, H. T. Lambrick (UK) raised some other questions before proposing his own theory. He pointed out that the impounded water would have gradually pushed back the area of siltation many kilometres up the valley and the siltation on the dam would not have reached as high as Raikes assumes. And if siltation did reach such a level, the colloidal clay particles would have sealed the dam into a solid structure which would have left some trace of its existence. But if the dam were permeable, would it not have collapsed under the impact of the water flowing at about 500,000 cu ft/sec during the floods? Lambrick himself thinks that the silt deposits at Mohenjodaro may have been caused either by the disintegration of mud bricks or the consolidation of windborne silt under rain and the pressure of the subsequent buildings. What finally ruined Mohenjodaro was " an ovulsion and a major change of course by the Indus, considerably upstream of the city ". The new river bed was lower, and the shift was so large that even flood waters from the river didn't reach the city and the neighbouring region. Cut off from water supply, Mohenjodaro began to wither. Lambrick, however, has no proofs yet to establish this theory.

In a recent study Gurdip Singh of the Australian National University, Canberra, (formerly of the Sahni Institute of Palaeobotany, Lucknow) suggests that a change from a wet to a dry climate was probably the cause of the Harappan decline. Based on carbon^{14} datings of stratified plant pollen, he observes that the beginning of the pre-Harappan and Harappan periods coincided with a wet phase. But around 1800 BC a period of aridity set in, and with it probably also the withering of the Harappan culture in the arid and semi-arid parts of north-west India. Fringe areas such as south Gujarat and the Himalayan foothills were, however, not affected as badly. The decline was a gradual process. The final blow, again, came from the marauders.

A recent Unesco report ascribes the decline to a rise in the water table and an increase in salinity both of which could have hit agriculture. But what caused these? Salinity probably increased in the estuarine areas because of the sea waters. A rise in the water table could have been caused by excessive use of water, or mismanagement of water resources.

K. P. N.



MUST WE MANIPULATE MAN?

LEON R. KASS

Efforts to eradicate human suffering raise difficult and profound questions of theory and practice

RECENT advances in biology and medicine suggest that we may be rapidly acquiring the power to modify and control the capacities and activities of men by direct intervention and manipulation of their bodies and minds. Certain means are already in use or at hand; others await the solution of relatively minor technical problems; while yet others, those offering perhaps the most precise kind of control, depend upon further basic research. Biologists who have considered these matters disagree on the question of how much how soon, but all agree that the power for " human engineering", to borrow from the jargon, is coming and that it will probably have profound social consequences.

These developments have been viewed both with enthusiasm and with alarm; they are only just beginning to receive serious attention. Several biologists have undertaken to inform the public about the technical possibilities, present and future. Practitioners of social science " futurology " are attempting to predict and describe the likely social consequences of and public responses to the new technologies. Lawyers and legislators are exploring institutional innovations for assessing new technologies. All of these activities are based upon the hope that we can harness the new technology of man for the betterment of mankind.

Yet this commendable aspiration points to another set of questions, which are, in my view, sorely neglected — questions that inquire into the meaning of phrases such as the betterment of mankind." A full understanding of the new technology of man requires an exploration of ends, values, standards. What ends will or should the new techniques serve? What values should guide society's adjustments? By what standards should the assessment agencies assess? Behind these questions lie others: what is a good man, what is a good life for man, what is a good community? This article is an attempt to provoke discussion of these neglected but important questions.

While these questions about ends and ultimate ends are never unimportant or irrelevant, they have rarely been more important or more relevant. That this is so can be seen once we recognise that we are dealing here with a group of technologies that are in a decisive respect unique: the object upon which they operate is man himself. The technologies of energy or food production, of communication, of manufacture and of motion greatly alter the implements available to man and the conditions in which he uses them. In contrast, the biomedical technology works to change the user himself. To be sure, the printing press, the automobile, the television, and the jet airplane have greatly altered the conditions under which and the way in which men live; but men as biological beings have remained largely unchanged. They have been, and remain, able to accept or reject, to use and abuse these technologies; they choose, whether wisely or foolishly, the ends to which these technologies are means. Biomedical technology may make it possible to change the inherent capacity for choice itself. Indeed, both those who welcome and those who fear the advent of " human engineering " ground their hopes and fears in the same prospect: that man can for the first time recreate himself.

Engineering the engineer seems to differ in kind from engineering his engine. Some have argued, however, that biomedical engineering does not differ qualitatively from toilet training, education, and moral teachings — all of which are forms of so-called " social engineering", which has man as its object, and is used by one generation to mould the next. In reply, it must at least be said that the techniques which have hitherto been employed are feeble and inefficient when compared to those on the horizon. This quantitative difference rests in part on a qualitative difference in the means of intervention. The traditional influences operate by speech or by symbolic deeds. They pay tribute to man as the animal who lives by speech and who understands the meanings of actions. Also, their effects are, in general, reversible, or at least subject to attempts at reversal. Each person has greater or lesser power to accept or reject or abandon them. In contrast, biomedical engineering circumvents the human context of speech and meaning, bypasses choice, and goes directly to work to modify the human material itself. Moreover, the changes wrought may be irreversible.

In addition, there is an important practical reason for considering the biomedical technology apart from other technologies. The advances we shall examine are fruits of a large, humane project dedicated to the conquest of disease and the relief of human suffering. The biologist and physician, regardless of their private motives, are seen, with justification, to be the well-wishers and benefactors of mankind. Thus, in a time in which technological advance is more carefully scrutinised and increasingly criticised, biomedical developments are still viewed by most people as benefits largely without qualification. The price we pay for these developments is thus more likely to go unrecognised. For this reason, I shall consider only the dangers and costs of biomedical advance. As the benefits are well known, there is no need to dwell upon them here. My discussion is deliberately partial.

I begin with a survey of the pertinent technologies. Next, I will consider some of the basic ethical and social problems in the use of these technologies. Then, I will briefly raise some fundamental questions to which these problems point. Finally, I shall offer some very general reflections on what is to be done.

The biomedical technologies

The biomedical technologies can be usefully organised into three groups, according to their major purpose: (*i*) control of death and life, (*ii*) control of human potentialities, and (*iii*) control of human achievement. The corresponding technologies are: (*i*) medicine, especially the arts of prolonging life and of controlling reproduction, (*ii*) genetic engineering and (*iii*) neurological and psychological manipulation. I shall briefly summarise each group of techniques.

1. *Control of death and life:* Previous medical triumphs have greatly increased average life expectancy. Yet other developments, such as organ transplantation or replacement and research into aging, hold forth the promise of increasing not just the average, but also the maximum life expectancy. Indeed, medicine seems to be sharpening its tools to do battle with death itself, as if death were just one more disease.

More immediately and concretely, available techniques of prolonging life — respirators, cardiac pacemakers, artificial kidneys — are already in the lists against death. Ironically, the success of these devices in forestalling death has introduced confusion in determining that death has, in fact, occurred. The traditional signs of

life — heartbeat and respiration — can now be maintained entirely by machines. Some physicians are now busily trying to devise so-called "new definitions of death," while others maintain that the technical advances show that death is not a concrete event at all, but rather a gradual process, like twilight, incapable of precise temporal localisation.

The real challenge to death will come from research into aging and senescence, a field just entering puberty. Recent studies suggest that aging is a genetically-controlled process, distinct from disease, but one that can be manipulated and altered by diet or drugs. Extrapolating from animal studies, some scientists have suggested that a decrease in the rate of aging might also be achieved simply by effecting a very small decrease in human body temperature. According to some estimates, by the year 2000 it may be technically possible to add from 20 to 40 useful years to the period of middle life.

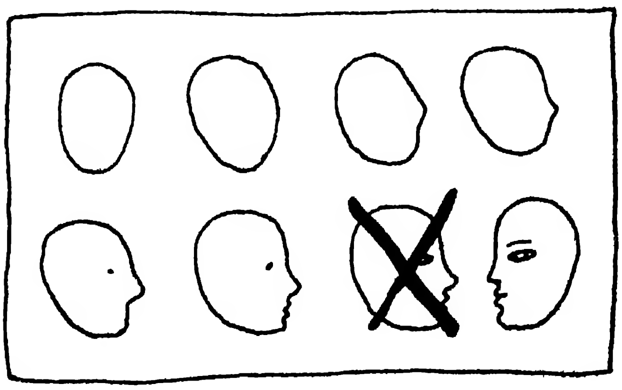
Medicine's success in extending life is already a major cause of excessive population growth: death control points to birth control. Although we are already technically competent, new techniques for lowering fertility and chemical agents for inducing abortion will greatly enhance our powers over conception and gestation. Problems of definition have been raised here as well. The need to determine when individuals acquire enforceable legal rights gives society an interest in the definition of human life and of the time when it begins. These matters are too familiar to need elaboration.

Technologies to conquer infertility proceed alongside those to promote it. The first successful laboratory fertilisation of human egg by human sperm was reported by R. G. Edwards, B. D. Bavister and P. C. Steptoe in 1969. In 1970, British scientists learned how to grow human embryos in the laboratory up to at least the blastocyst stage (that is, to the age of one week). We may soon hear about the next stage, the successful reimplantation of such an embryo into a woman previously infertile because of oviduct disease. The development of an artificial placenta, now under investigation, will make possible full laboratory control of fertilisation and gestation. In addition, sophisticated biochemical and cytological techniques of monitoring the "quality" of the foetus have been and are being developed and used. These developments not only give us more power over the generation of human life, but make it possible to manipulate and to modify the quality of the human material.

2. *Control of human potentialities:* Genetic engineering, when fully developed, will wield two powers not shared by ordinary medical practice. Medicine treats existing individuals and seeks to correct deviations from a norm of health. Genetic engineering, in contrast, will be able to make changes that can be transmitted to succeeding generations and will be able to create new capacities, and hence to establish new norms of health and fitness.

Nevertheless, one of the major interests in genetic manipulation is strictly medical: to develop treatments for individuals with inherited diseases. Genetic disease is prevalent and increasing, thanks partly to medical advances that enable those affected to survive and perpetuate their mutant genes. The hope is that normal copies of the appropriate gene, obtained biologically or synthesised chemically, can be introduced into defective individuals to correct their deficiencies. This therapeutic use of genetic technology appears to be far in the future. Moreover, there is some doubt that it will ever be practical, since the same end could be more easily achieved by transplanting cells or organs that could compensate for the missing or defective gene product.

Far less remote are technologies that could serve eugenic ends. Their development has been endorsed by those concerned about a general deterioration of the human gene pool and by others who believe that even an undeteriorated human gene pool needs upgrading. Artificial insemination with selected donors, the eugenic proposal of Herman Muller, has been possible for several years because of the perfection of methods for long-term storage of human spermatozoa. The successful maturation of human oocytes in the laboratory and their subsequent fertilisation now make it possible to



select donors of ova as well. But a far more suitable technique for eugenic purposes will soon be upon us — namely, nuclear transplantation, or cloning. Bypassing the lottery of sexual recombination, nuclear transplantation permits the asexual reproduction or copying of an already developed individual. The nucleus of a mature but unfertilised egg is replaced by a nucleus obtained from a specialised cell of an adult organism or embryo (for example, a cell from the intestines or the skin). The egg with its transplanted nucleus develops as if it had been fertilised and, barring complications, will give rise to a normal adult organism. Since almost all the hereditary material (DNA) of a cell is contained within its nucleus, the renucleated egg and the individual into which it develops are genetically identical to the adult organism that was the source of the donor nucleus. Cloning could be used to produce sets of unlimited numbers of genetically identical individuals, each set derived from a single parent. Cloning has been successful in amphibians and is now being tried in mice; its extension to man merely requires the solution of certain technical problems.

Production of man-animal chimeras by the introduction of selected non-human material into developing human embryos is also expected. Fusion of human and non-human cells in tissue culture has already been achieved.

Other less direct means for influencing the gene pool are already available, thanks to our increasing ability to identify and diagnose genetic diseases. Genetic counselors can now detect biochemically and cytologically a variety of severe genetic defects (for example, Mongolism, Tay-Sachs disease) while the foetus is still in utero. Since treatments are at present largely unavailable, diagnosis is often followed by abortion of the affected foetus. In the future, more sensitive tests will also permit the detection of heterozygote carriers, the unaffected individuals who carry but a single dose of a given deleterious gene. The eradication of a given genetic disease might then be attempted by aborting all such carriers. In fact, it was recently suggested that the fairly common disease cystic fibrosis could be completely eliminated over the next 40 years by screening all pregnancies and aborting the 17,000,000 unaffected foetuses that will carry a single gene for this disease. Such zealots need to be reminded of the consequences should each geneticist be allowed an equal assault on his favourite genetic disorder, given that each human being is a carrier for some four to eight such recessive, lethal genetic diseases.

3. *Control of human achievement:* Although human achievement depends at least in part upon genetic endowment, heredity determines only the material upon which experience and education impose the form. The limits of many capacities and powers of an individual are indeed genetically determined, but the nurturing and perfection of these capacities depend upon other influences. Neurological and psychological manipulation hold forth the promise of controlling the development of human capacities, particularly those long considered most distinctively human: speech, thought, choice, emotion, memory, and imagination.

These techniques are now in a rather primitive state because we understand so little about the brain and mind. Nevertheless, we have already seen the use of electrical stimulation of the human brain to produce sensations of intense pleasure and to control rage, the use of brain surgery (for example, frontal lobotomy) for the relief of severe anxiety, and the use of aversive conditioning with electric shock to treat sexual perversion. Operant-conditioning techniques are widely used, apparently with success, in schools and mental hospitals. The use of so-called consciousness-expanding and hallucinogenic drugs is widespread, to say nothing of tranquilisers and stimulants. We are promised drugs to modify memory, intelligence, libido, and aggressiveness.

The following passages from a recent book by Yale neurophysiologist Jose Delgado — a book instructively entitled *Physical Control of the Mind: Toward a Psychocivilized Society* — should serve to make this discussion more concrete. In the early 1950s, it was discovered that, with electrodes placed in certain discrete regions of their brains, animals would repeatedly and indefatigably press levers to stimulate their own brains, with obvious resultant enjoyment. Even starving animals preferred stimulating these so-called pleasure centres to eating. Delgado comments on the electrical stimulation of a similar centre in a human subject:

> (T)he patient reported a pleasant tingling sensation in the left side of her body " from my face down to the bottom of my legs." She started giggling and making funny comments, stating that she enjoyed the sensation " very much". Repetition of these stimulations made the patient more communicative and flirtatious, and she ended by openly expressing her desire to marry the therapist.

[They] speak of "the control of nature by science". It is men who control, not that abstraction "science". Science may provide the means, but men choose the ends; the choice of ends comes from beyond science

And one further quotation from Delgado:

> Leaving wires inside of a thinking brain may appear unpleasant or dangerous, but actually the many patients who have undergone this experience have not been concerned about the fact of being wired, nor have they felt any discomfort due to the presence of conductors in their heads. Some women have shown their feminine adaptability to circumstances by wearing attractive hats or wigs to conceal their electrical headgear, and many people have been able to enjoy a normal life as out-patients, returning to the clinic periodically for examination and stimulation. In a few cases in which contacts were located in pleasurable areas, patients have had the opportunity to stimulate their own brains by pressing the button of a portable instrument, and this procedure is reported to have therapeutic benefits.

It bears repeating that the sciences of neurophysiology and psychopharmacology are in their infancy. The techniques that are now available are crude, imprecise, weak, and unpredictable, compared to those that may flow from a more mature neurobiology.

Basic ethical and social problems

After this cursory review of the powers now and soon to be at our disposal, I turn to the questions concerning the use of these powers. First, we must recognise that questions of use of science and technology are always moral and political questions, never simply technical ones. All private or public decisions to develop or to use biomedical technology — and decisions not to do so — inevitably contain judgments about value. This is true even if the values guiding those decisions are not articulated or made clear, as indeed they often are not. Secondly, the value judgments cannot be derived from biomedical science. This is true even if scientists themselves make the decisions.

These important points are often overlooked for at least three reasons.

1) They are obscured by those who like to speak of " the control of nature by science ". It is men who control, not that abstraction " science ". Science may provide the means, but men choose the ends; the choice of ends comes from beyond science.

2) Introduction of new technologies often appears to be the result of no decision whatsoever, or of the culmination of decisions too small or unconscious to be recognised as such. What can be done is done. However, someone is deciding on the basis of some notions of desirability, no matter how self-serving or altruistic.

3) Desires to gain or keep money and power no doubt influence much of what happens, but these desires can also be formulated as reasons and then discussed and debated.

Insofar as our society has tried to deliberate about questions of use, how has it done so? Pragmatists that we are, we prefer a utilitarian calculus: we weight " benefits " against " risks," and we weight them for both the individual and " society". We often ignore the fact that the very definitions of " a benefit " and " a risk " are themselves based upon judgments about value. In the biomedical areas just reviewed, the benefits are considered to be self-evident: prolongation of life, control of fertility and of population size, treatment and prevention of genetic diseases, the reduction of anxiety and aggressiveness, and the enhancement of memory, intelligence, and pleasure. The assessment of risk is, in general, simply pragmatic — will the technique work effectively and reliably, how much will it cost, will it do detectable bodily harm, and who will complain if we proceed with development? As these questions are familiar and congenial, there is no need to belabour them.

The very pragmatism that makes us sensitive to considerations of economic cost often blinds us to the larger social costs exacted by biomedical advances. For one thing, we seem to be unaware that we may not be able to maximise all the benefits, that several of the goals we are

promoting conflict with each other. On the one hand, we seek to control population growth by lowering fertility; on the other hand, we develop techniques to enable every infertile woman to bear a child. On the one hand, we try to extend the lives of individuals with genetic disease; on the other, we wish to eliminate deleterious genes from the human population. I am not urging that we resolve these conflicts in favour of one side or the other, but simply that we recognise that such conflicts exist. Once we do, we are more likely to appreciate that most "progress" is heavily paid for in terms not generally included in the simple utilitarian calculus.

To become sensitive to the larger costs of biomedical progress, we must attend to several serious ethical and social questions. I will briefly discuss three of them: (*i*) questions of distributive justice, (*ii*) questions of the use and abuse of power, and (*iii*) questions of self-degradation and dehumanisation.

Distributive justice

The introduction of any biomedical technology presents a new instance of an old problem — how to distribute scarce resources justly. We should assume that demand will usually exceed supply. Which people should receive a kidney transplant or an artificial heart? Who should get the benefits of genetic therapy or brain stimulation? Is "first-come, first-served" the fairest principle? Or are certain people "more worthy," and if so, on what grounds?

It is unlikely that we will arrive at answers to these questions in the form of deliberate decisions. More likely, the problem of distribution will continue to be decided ad hoc and locally. If so, the consequence will probably be a sharp increase in the already far too great inequality of medical care. The extreme case will be longevity, which will probably be, at first, obtainable only at great expense. Who is likely to be able to buy it? Do conscience and prudence permit us to enlarge the gap between rich and poor, especially with respect to something as fundamental as life itself?

Questions of distributive justice also arise in the earlier decisions to acquire new knowledge and to develop new techniques. Personnel and facilities for medical research and treatment are scarce resources. Is the development of a new technology the best use of the limited resources, given current circumstances? How should we balance efforts aimed at prevention against those aimed at cure, or either of these against efforts to redesign the species? How should we balance the delivery of available levels of care against further basic research? More fundamentally, how should we balance efforts in biology and medicine against efforts to eliminate poverty, pollution, urban decay, discrimination, and poor education? This last question about distribution is perhaps the most profound. We should reflect upon the social consequences of seducing many of our brightest young people to spend their lives locating the biochemical defects in rare genetic diseases, while our more serious problems go begging. The current squeeze on money for research provides us with an opportunity to rethink and reorder our priorities.

Problems of distributive justice are frequently mentioned and discussed, but they are hard to resolve in a rational manner. We find them especially difficult because of the enormous range of conflicting values and interests that characterises our pluralistic society. We cannot agree — unfortunately, we often do not even try to agree — on standards for just distribution. Rather, decisions tend to be made largely out of a clash of competing interests. Thus, regrettably, the question of how to distribute justly often gets reduced to who shall decide how to distribute. The question about justice has led us to the question about power.

Use and abuse of power

We have difficulty recognising the problems of the exercise of power in the biomedical enterprise because of our delight with the wondrous fruits it has yielded. This is ironic because the notion of power is absolutely central to the modern conception of science. The ancients conceived of science as the understanding of nature, pursued for its own sake. We moderns view science as power, as control over nature; the conquest of nature "for the relief of man's estate" was the charge issued by Francis Bacon, one of the leading architects of the modern scientific project.

Another source of difficulty is our fondness for speaking of the abstraction "Man". I suspect that we prefer to speak figuratively about "Man's power over Nature" because it obscures an unpleasant reality about human affairs. It is in fact particular men who wield power, not Man. What we really mean by "Man's power over Nature" is a power exercised by some men over other men, with a knowledge of nature as their instrument.

While applicable to technology in general, these reflections are especially pertinent to the technologies of human engineering, with which men deliberately exercise power over future generations. An excellent discussion of this question is found in *The Abolition of Man* by C. S. Lewis.

> It is, of course, a commonplace to complain that men have hitherto used badly, and against their fellows, the powers that science has given them. But that is not the point I am trying to make. I am not speaking of particular corruptions and abuses which an increase of moral virtue would cure: I am considering what the thing called " Man's power over Nature " must always and essentially be . . .
>
> In reality, of course, if any one age really attains, by eugenics and scientific education, the power to make its descendants what it pleases, all men who live after it are the patients of that power. They are weaker, not stronger: for though we may have put wonderful machines in their hands, we have pre-ordained how they are to use them . . . . The real picture is that of one dominant age . . . which resists all previous ages most successfully and dominates all subsequent ages most irresistibly, and thus is the real master of the human species. But even within this master generation (itself an infinitesimal minority of the species) the power will be exercised by a minority smaller still. Man's conquest of Nature, if the dreams of some scientific planners are realised, means the rule of a few hundred men over billions upon billions of men. There neither is nor can be any simple increase of power on Man's side. Each new power won *by* man is a power *over* man as well. Each advance leaves him weaker as well as stronger. In every victory, besides being the general who triumphs, he is also the prisoner who follows the triumphal car.

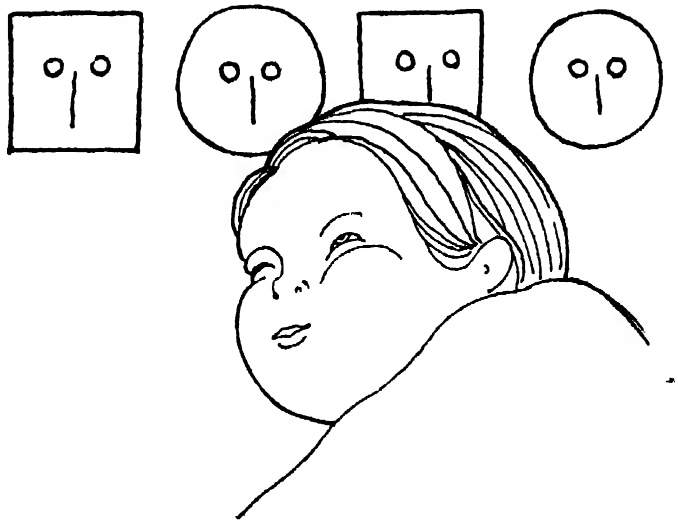
Please note that I am not yet speaking about the problem of the misuse or abuse of power. The point is rather that the power which grows is unavoidably the power of only some men, and that the number of powerful men decreases as power increases.

Specific problems of abuse and misuse of specific powers must not, however, be overlooked. Some have voiced the fear that the technologies of genetic engineering and behaviour control, though developed for good purposes, will be put to evil uses. These fears are perhaps somewhat exaggerated, if only because biomedical technologies would add very little to our highly developed arsenal for mischief, destruction, and stultification. Nevertheless, any proposal for large-scale human engineering should make us wary. Consider a programme of positive eugenics based upon the widespread practice of asexual reproduction. Who shall decide what constitutes a superior individual worthy of replication? Who shall decide which individuals may or must reproduce, and by which method? These are questions easily answered only for a tyrannical regime.

Concern about the use of power is equally necessary in the selection of means for desirable or agreed-upon ends. Consider the desired end of limiting population growth. An effective programme of fertility control is likely to be coercive. Who should decide the choice of means? Will the programme penalise " conscientious objectors "?

Serious problems arise simply from obtaining and disseminating information, as in the mass screening programmes now being proposed for detection of genetic disease. For what

Physicians are sometimes troubled by their increasing power, yet they feel they cannot avoid its exercise. "Reluctantly", one commented to me, "we shall have to play God"...... I merely ask: "By whose authority?"



kinds of disorders is compulsory screening justified? Who shall have access to the data obtained, and for what purposes? To whom does information about a person's genotype belong? In ordinary medical practice, the patient's privacy is protected by the doctor's adherence to the principle of confidentiality. What will protect his privacy under conditions of mass screening?

More than privacy is at stake if screening is undertaken to detect psychological or behavioral abnormalities. A recent proposal, tendered and supported high in government, called for the psychological testing of all 6-year-olds to detect future criminals and misfits. The proposal was rejected; current tests lack the requisite predictive powers. But will such a proposal be rejected if reliable tests become available? What if certain genetic disorders, diagnosable in childhood, can be shown to correlate with subsequent antisocial behaviour? For what degree of correlation and for what kinds of behaviour can mandatory screening be justified? What use should be made of the data? Might not the dissemination of the information itself undermine the individual's chance for a worthy life and contribute to his so-called antisocial tendencies?

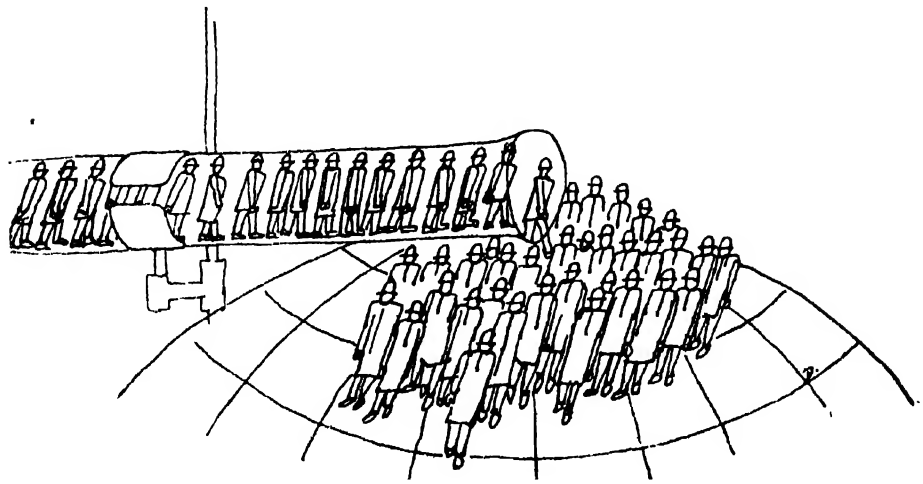
Consider the seemingly harmless effort to redefine clinical death. If the need for organs for transplantation is the stimulus for redefining death, might not this concern influence the definition at the expense of the dying? One physician, in fact, refers in writing to the revised criteria for declaring a patient dead as a " new definition of heart donor eligibility ".

Problems of abuse of power arise even in the acquisition of basic knowledge. The securing of a voluntary and informed consent is an abiding problem in the use of human subjects in experimentation. Gross coercion and deception are now rarely a problem; the pressures are generally subtle, often related to an intrinsic power imbalance in favour of the experimentalist.

A special problem arises in experiments on or manipulations of the unborn. Here it is impossible to obtain the consent of the human subject. If the purpose of the intervention is therapeutic — to correct a known genetic abnormality, for example — consent can reasonably be implied. But can anyone ethically consent to nontherapeutic interventions in which parents or scientists work their wills or their eugenic visions on the child-to-be? Would not such manipulation represent in itself an abuse of power, independent of consequences?

There are many clinical situations which already permit, if not invite, the manipulative or arbitrary use of powers provided by biomedical technology: obtaining organs for transplantation, refusing to let a person die with dignity, giving genetic counselling to a frightened couple, recommending eugenic sterilisation for a mental retardate, ordering electric shock for a homosexual. In each situation, there is an opportunity to violate the will of the patient or subject. Such opportunities have generally existed in medical practice, but the dangers are becoming increasingly serious. With the growing complexity of the technologies, the technician gains in authority, since he alone can understand what he is doing. The patient's lack of knowledge makes him deferential and often inhibits him from speaking up when he feels threatened. Physicians are sometimes troubled by their increasing power, yet they feel they cannot avoid its exercise. " Reluctantly," one commented to me, " we shall have to play God." With what guidance and to what ends, I shall consider later. For the moment, I merely ask: " By whose authority? "

While these questions about power are pertinent and important, they are in one sense



Biomedical engineering circumvents the human context of speech and meaning, bypasses choice, and goes directly to modify the human material itself. The change may be irreversible

misleading. They imply an inherent conflict of purpose between physician and patient, between scientist and citizen. The discussion conjures up images of master and slave, of oppressor and oppressed. Yet it must be remembered that conflict of purpose is largely absent, especially with regard to general goals. To be sure, the purposes of medical scientists are not always the same as those of the subjects experimented on. Nevertheless, basic sponsors and partisans of biomedical technology are precisely those upon whom the technology will operate. The will of the scientist and physician is happily married to (rather, is the offspring of) the desire of all of us for better health, longer life, and peace of mind.

Most future biomedical technologies will probably be welcomed, as have those of the past. Their use will require little or no coercion. Some developments, such as pills to improve memory, control mood, or induce pleasure, are likely to need no promotion. Thus, even if we should escape from the dangers of coercive manipulation, we shall still face large problems posed by the voluntary use of biomedical technology, problems to which I now turn.

Voluntary self-degradation and dehumanisation

Modern opinion is sensitive to problems of restriction of freedom and abuse of power. Indeed, many hold that a man can be injured only by violating his will. But this view is much too narrow. It fails to recognise the great dangers we shall face in the use of biomedical technology, dangers that stem from an excess of freedom, from the uninhibited exercises of will. In my view, our greatest problem will increasingly be done of voluntary self-degradation, or willing dehumanisation.

Certain desired and perfected medical technologies have already had some dehumanising consequences. Improved methods of resuscitation have made possible heroic efforts to "save" the severely ill and injured. Yet these efforts are sometimes only partly successful; they may succeed in salvaging individuals with severe brain damage, capable of only a less-than-human, vegetating existence. Such patients, increasingly found in the intensive care units of university hospitals, have been denied a death with dignity. Families are forced to suffer seeing their loved ones so reduced, and are made to bear the burdens of a protracted death watch.

Even the ordinary methods of treating disease and prolonging life have impoverished the context in which men die. Fewer and fewer people die in the familiar surroundings of home or in the company of family and friends. At that time of life when there is perhaps the greatest need for human warmth and comfort, the dying patient is kept company by cardiac pace-makers and defibrillators, respirators, aspirators, oxygenators, catheters, and his intravenous drip.

But the loneliness is not confined to the dying patient in the hospital bed. Consider the increasing number of old people who are still alive, thanks to medical progress. As a group, the elderly are the most alienated members of our society. Not yet ready for the world of the dead, not deemed fit for the world of the living, they are shunted aside. More and more of them spend the extra years medicine has given them in "homes for senior citizens," in chronic hospitals, in nursing homes — waiting for the end. We have learned how to increase their years, but we have not learned how to help them enjoy their days. And yet, we bravely and relentlessly push back the frontiers against death.

Paradoxically, even the young and vigorous may be suffering because of medicine's success in removing death from their personal experience. Those born since penicillin represent the first generation ever to grow up without the experience or fear of probable unexpected death at an early age. They look around and see that virtually all of their friends are alive. A thoughtful physician, Eric Cassell, has remarked on this in "*Death and the physician*" (in *Commentary*):

> [W]hile the gift of time must surely be marked as a great blessing, the perception of time, as stretching out endlessly before us, is somewhat threatening. Many of us function best under deadlines, and tend to procrastinate when time limits are not set. . . . . . Thus, this unquestioned boon, the extension of life, and the removal of the threat of premature death, carries with it an unexpected anxiety: the anxiety of an unlimited future.
>
> In the young, the sense of limitless time has apparently imparted not a feeling of limitless opportunity, but increased stress and anxiety, in addition to the anxiety which results from other modern freedoms: personal mobility, a wide range of occupational choice, and independence from the limitations of class and familial patterns of work . . . . . A certain aimlessness (often ringed around with great social

consciousness) characterises discussions about their own aspirations. The future is endless, and their inner demands seem minimal. Although it may appear uncharitable to say so, they seem to be acting in a way best described as "childish" — particularly in their lack of a time sense. They behave as though there were no tomorrow, or as though the time limits imposed by the biological facts of life had become so vague for them as to be non-existent.

Consider next the coming power over reproduction and genotype. We endorse the project that will enable us to control numbers and to treat individuals with genetic disease. But our desires outrun these defensible goals. Many would welcome the chance to become parents without the inconvenience of pregnancy; others would wish to know in advance the characteristics of their offspring (sex, height, eye colour, intelligence); still others would wish to design these characteristics to suit their tastes. Some scientists have called for the use of the new technologies to assure the "quality" of all new babies. As one obstetrician put it: "The business of obstetrics is to produce optimum babies." But the price to be paid for the "optimum baby" is the transfer of procreation from the home to the laboratory and its coincident transformation into manufacture. Increasing control over the product is purchased by the increasing depersonalisation of the process. The complete depersonalisation of procreation (possible with the development of an artificial placenta) shall be, in itself, seriously dehumanising, no matter how optimum the product. It should not be forgotten that human procreation not only issues new human beings, but is itself a human activity.

Procreation is not simply an activity of the rational will. It is a more complete human activity precisely because it engages us bodily and spiritually, as well as rationally. Is there perhaps some wisdom in that mystery of nature which joins the pleasure of sex, the communication of love, and the desire for children in the very activity by which we continue the chain of human existence? Is not biological parenthood a built-in "mechanism," selected because it fosters and supports in parents an adequate concern for an commitment to their children? Would not the laboratory production of human beings no longer be human procreation? Could it keep human parenthood human?

The dehumanising consequences of programmed reproduction extend beyond the mere acts and processes of life-giving. Transfer of procreation to the laboratory will no doubt weaken what is presently for many people the best remaining justification and support for the existence of marriage and the family. Sex is now comfortably at home outside of marriage; child-rearing is progressively being given over to the state, the schools, the mass media, and the child-care centres. Some have argued that the family, long the nursery of humanity, has outlived its usefulness. To be sure, laboratory and governmental alternatives might be designed for procreation and child-rearing, but at what cost?

That is not the place to conduct a full evaluation of the biological family. Nevertheless, some of its important virtues are, nowadays, too often overlooked. The family is rapidly becoming the only institution in an increasingly impersonal world where each person is loved not for what he does or makes, but simply because he is. The family is also the institution where most of us, both as children and as parents, acquire a sense of continuity with the past and a sense of commitment to the future. Without the family, we would have little incentive to take an interest in anything after our own deaths. These observations suggest that the elimination of the family would weaken ties to past and future, and would throw us, even more than we are now, to the mercy of an impersonal, lonely present.

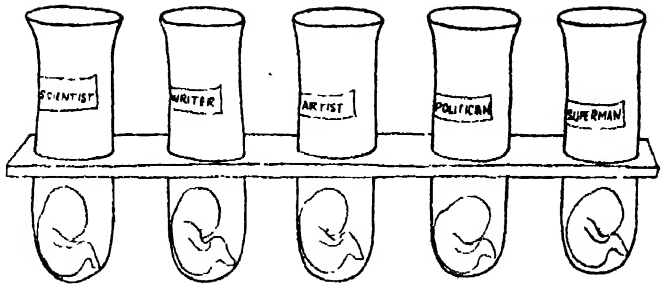
Neurobiology and psychobiology probe most directly into the distinctively human. The technological fruit of these sciences is likely to be both more tempting than Eve's apple and more "catastrophic" in its result. [It is, of course, a long-debated question as to whether the fall of Adam and Eve ought to be considered "catastrophic," or more precisely, whether the Hebrew tradition considered it so. I do not mean here to be taking sides in this quarrel by my use of the term "catastrophic," and, in fact, tend to line up on the negative side of the questions, as put above. Curiously, as Aldous Huxley's *Brave New World* (Harper & Row, New York, 1969) suggests, the implicit goal of the biomedical technology could well be said to be the reversal of the Fall and a return of man to the hedonic and immortal existence of the Garden of Eden. Yet I can point to at least two problems. First, the new Garden of Eden will probably have no gardens; the received, splendid world of nature will be buried beneath asphalt, concrete, and other human fabrications, a transformation that is already far along. (Recall that in *Brave New World* elaborate

consumption-oriented, mechanical amusement parks — featuring, for example, centrifugal bumble-puppy — had supplanted wilderness and even ordinary gardens.) Second, the new inhabitant of the new " Garden " will have to be a creature as difficult to imagine as to bring into existence. He will have to be simultaneously an innocent like Adam and a technological wizard who keeps the " Garden " running. (I am indebted to Dean Robert Goldwin, St. John's College, for this last insight.)] One need only consider contemporary drug use to see what people are willing to risk or sacrifice for novel experiences, heightened perceptions, or just " kicks ". The possibility of drug-induced, instant and effortless gratification will be welcomed. Recall the possibilities of voluntary self-stimulation of the brain to reduce anxiety, to heighten pleasure, or to create visual and auditory sensations unavailable through the peripheral sense organs. Once these techniques are perfected and safe, is there much doubt that they will be desired, demanded and used?

What ends will these techniques serve? Most likely, only the most elemental, those most tied to the bodily pleasures. What will happen to thought, to love, to friendship, to art, to judgment, to public-spiritedness in a society with a perfected technology of pleasure? What kinds of creatures will we become if we obtain our pleasure by drug or electrical stimulation without the usual kind of human efforts and frustrations? What kind of society will we have?

We need only consult Aldous Huxley's prophetic novel *Brave New World* for a likely answer to these questions. There we encounter a society dedicated to homogeneity and stability, administered by means of instant gratifications and peopled by creatures of human shape but of stunted humanity. They consume, fornicate, take " soma " and operate the machinery that makes it all possible. They do not read, write, think, love, or govern themselves. Creativity and curiosity, reason and passion, exist only in a rudimentary and multilated form. In short, they are not men at all.

True, our techniques, like theirs, may in fact enable us to treat schizophrenia, to alleviate anxiety, to curb aggressiveness. We, like they, may indeed be able to save mankind from itself, but probably only at the cost of its humanness. In the end, the price of relieving man's estate might well be the abolition of man. [Some scientists naively believe that an engineered increase in human intelligence will steer us in the right direction. Surely we have learned by now that intelligence, whatever it is and however measured, is not synonymous with wisdom and that, if harnessed to the wrong ends, it can cleverly perpetrate great folly and evil. Given the activities in which many, if not most, of our best minds are now engaged, we should not simply rejoice in the prospect of enhancing IQ. On what would this increased intelligence operate? At best, the programming of further increases in IQ. It would design and operate techniques for prolonging life, for engineering reproduction, for delivering gratifications. With no gain in wisdom, our gain in intelligence can only enhance the rate of our dehumanisation.]



There are, of course, many other routes leading to the abolition of man. There are many other and better known causes of dehumanisation. Disease, starvation, mental retardation, slavery, and brutality — to name just a few -- have long prevented many, if not most, people from living a fully human life. We should work to reduce and eventually to eliminate these evils. But the existence of these evils should not prevent us from appreciating that the use of the technology of man, uninformed by wisdom concerning proper human ends, and untempered by an appropriate humility and awe, can unwittingly render us all irreversibly less than human. For, unlike the man reduced by disease or slavery, the people dehumanised a la Brave New World are not miserable, do not know that they are dehumanised, and, what is worse, would not care if they knew. They are, indeed, happy slaves, with a slavish happiness.

Some fundamental questions

The practical problems of distributing scarce resources, of curbing the abuses of power, and of preventing voluntary dehumanisation point beyond themselves to some large, enduring, and most difficult questions: the nature of justice and the good community, the nature of man

and the good for man. My appreciation of the profundity of these questions and my own ignorance before them makes me hesitant to say any more about them. Nevertheless, previous failures to find a shortcut around them have led me to believe that these questions must be faced if we are to have any hope of understanding where biology is taking us. Therefore, I shall try to show in outline how I think some of the larger questions arise from my discussion of dehumanisation and self-degradation.

My remarks on dehumanisation can hardly fail to arouse argument. It might be said, correctly, that to speak about dehumanisation presupposes a concept of " the distinctively human ". It might also be said, correctly, that to speak about wisdom concerning proper human ends presupposes that such ends do in fact exist and that they may be more or less accessible to human understanding, or at least to rational inquiry. It is true that neither presupposition is at home in modern thought.

The notion of the " distinctively human " has been seriously challenged by modern scientists. Darwinists hold that man is, at least in origin, tied to the subhuman; his seeming distinctiveness is an illusion or, at most, not very important. Biochemists and molecular biologists extend the challenge by blurring the distinction between the living and the nonliving. The laws of physics and the chemistry are found to be valid and are held to be sufficient for explaining biological systems. Man is a collection of molecules, an accident on the stage of evolution, endowed by chance with the power to change himself, but only along determined lines.

What makes man better ?

Psychoanalysts have also debunked the " distinctly human ". The essence of man is seen to be located in those drives he shares with other animals — pursuit of pleasure and avoidance of pain. The so-called " higher functions " are understood to be servants of the more elementary, the more base. Any distinctiveness or " dignity " that man has consists of his superior capacity for gratifying his animal needs.

The idea of " human good " fares no better. In the social sciences, historicists and existentialists have helped drive this question underground. The former hold all notions of human good to be culturally and historically bound, and hence mutable. The latter hold that values are subjective: each man makes his own, and ethics becomes simply the cataloging of personal tastes.

Such appear to be the prevailing opinions. Yet there is nothing novel about reductionism, hedonism, and relativism; these are doctrines with which Socrates contended. What is new is that these doctrines seem to be vindicated by scientific advance. Not only do the scientific notions of nature and of man flower into verifiable predictions, but they yield marvellous fruit. The technological triumphs are held to validate their scientific foundations. Here, perhaps, is the most pernicious result of technological progress — more dehumanising than any actual manipulation of technique, present or future. We are witnessing the erosion, perhaps the final erosion, of the idea of man as something splendid or divine, and its replacement with a view that sees man, no less than nature, as simply more raw material for manipulation and homogenisation. Hence, our peculiar moral crisis. We are in turbulent seas without a landmark precisely because we adhere more and more to a view of nature and of man which both gives us enormous power and, at the same time, denies all possibility of standards to guide its use. Though well-equipped, we know not who we are nor where we are going. We are left to the accidents of our hasty, biased and ephemeral judgments.

Let us not fail to note a painful irony: our conquest of nature has made us the slaves of blind chance. We triumph over nature's unpredictabilities only to subject ourselves to the still greater unpredictability of our capricious wills and our fickle opinions. That we have a method is no proof against our madness. Thus, engineering the engineer as well as the engine, we race our train we know not where. [The philosopher Hans Jonas has made the identical point: " Thus the slow-working accidents of nature, which by the very patience of their small increments, large numbers and gradual decisions, may well cease to be ' accident ' in outcome, are to be replaced by the fast-working accidents of man's hasty and biased decisions, not exposed to the long test of the ages. His uncertain ideas are to set the goals of generations, with a certainty borrowed from the presumptive certainty of the means. The latter presumption is doubtful enough, but this doubtfulness becomes secondary to the prime question that arises when man indeed undertakes to ' make himself ': in what image of his own devising shall he do so, even granted that he can be sure of the means? In fact, of course, he

can be sure of neither, not of the end, nor of the means, once he enters the realm where he plays with the roots of life. Of one thing only can he be sure: of his power to move the foundation and to cause incalculable and irreversible consequences. Never was so much power coupled with so little guidance for its use." (*J. Cent. Conf. Amer. Rabbis, January 1968,* p. 27.) These remarks demonstrate that contrary to popular belief, we are not even on the right road toward a rational understanding of and rational control over human nature and human life. It is indeed the height of irrationality triumphantly to pursue rationalised technique, while at the same time insisting that questions of ends, values and purposes lie beyond rational discourse.]

While the disastrous consequences of ethical nihilism are insufficient to refute it, they invite and make urgent a reinvestigation of the ancient and enduring questions of what is a proper life for a human being, what is a good community, and how are they achieved. [It is encouraging to note that these questions are seriously being raised in other quarters — for example, by persons concerned with the decay of cities or the pollution of nature. There is a growing dissatisfaction with ethical nihilism. In fact, its tenets are unwittingly abandoned, by even its staunchest adherents, in any discussion of " what to do ". For example, in the biomedical area, everyone, including the most unreconstructed and technocratic reductionist, finds himself speaking about the use of powers for " human betterment". He has wandered unawares onto ethical ground. One cannot speak of " human betterment " without considering what is meant by *the human* and by the related notion of *the good for man*. These questions can be avoided only by asserting that practical matters reduce to tastes and power, and by confessing that the use of the phrase " human betterment " is a deception to cloak one's own will to power. In other words, these questions can be avoided only by ceasing to discuss.] We must not be deterred from these questions simply because the best minds in human history have failed to settle them. Should we not rather be encouraged by the fact that they considered them to be the most important questions?

As I have hinted before, our ethical dilemma is caused by the victory of modern natural science with its nonteleological view of man. We ought therefore to re-examine with great care the modern notions of nature and of man, which undermine those earlier notions that provide a basis for ethics. If we consult our common experience, we are likely to discover some grounds for believing that the questions about man and human good are far from closed. Our common experience suggests many difficulties for the modern " scientific view of man." For example, this view fails to account for the concern for justice and freedom that appears to be characteristic of all human societies. It also fails to account for or to explain the fact that men have speech and not merely voice, that men can choose and act and not merely move or react. It fails to explain why men engage in moral discourse, or, for that matter, why they speak at all. Finally, the " scientific view of man " cannot account for scientific inquiry itself, for why men seek to know. Might there not be something the matter with a knowledge of man that does not explain or take account of his most distinctive activities, aspirations, and concerns?

Having gone this far, let me offer one suggestion as to where the difficulty might lie: in the modern understanding of knowledge. Since Bacon, as I have mentioned earlier, technology has increasingly come to be the basic justification for scientific inquiry. The end is power, not knowledge for its own sake. But power is not only the end. It is also an important validation of knowledge. One definitely knows that one knows only if one can make. Synthesis is held to be the ultimate proof of understanding. [This belief, silently shared by many contemporary biologists, has recently been given the following clear expression: "One of the acid tests of understanding an object is the ability to put it together from its component parts. Ultimately, molecular biologists will attempt to subject their understanding of all structure and function to this sort of test by trying to synthesise a cell. It is of some interest to see how close we are to this goal." (P. Handler, Ed, *Biology and the Future of Man,* Oxford Univ. Press, New York, 1970, p. 55.)] A more radical formulation holds that one knows only what one makes: knowing equals making.

Yet therein lies a difficulty. If truth be the power to change or to make the object studied, then of what do we have knowledge? If there are no fixed realities, but only material upon which we may work our wills, will not " science " be merely the " knowledge " of the transient and the manipulatable? We might indeed have knowledge of the laws by which things change and the rules for their manipulation,

but no knowledge of the things themselves. Can such a view of " science " yield any knowledge about the nature of man, or indeed, about the nature of anything? Our questions appear to lead back to the most basic of questions: What does it mean to know? What is it that is knowable?

We have seen that the practical problems point toward and make urgent certain enduring, fundamental questions. Yet while pursuing these questions, we cannot afford to neglect the practical problems as such. Let us not forget Delgado and the " psychocivilised society." The philosophical inquiry could be rendered moot by our blind, confident efforts to dissect and redesign ourselves. While awaiting a reconstruction of theory, we must act as best we can.

What is to be done?

First, we sorely need to recover some humility in the face of our awesome powers. The arguments I have presented should make apparent the folly of arrogance, of the presumption that we are wise enough to remake ourselves. Because we lack wisdom, caution is our urgent need. Or to put it another way, in the absence of that " ultimate wisdom," we can be wise enough to know that we are not wise enough. When we lack sufficient wisdom to do, wisdom consists in not doing. Caution, restraint, delay, abstention are what this second-best (and, perhaps, only) wisdom dictates with respect to the technology for human engineering.

If we can recognise that biomedical advances carry significant social costs, we may be willing to adopt a less permissive, more critical stance toward new developments. We need to re-examine our prejudice not only that all biomedical innovation is progress, but also that it is inevitable. Precedent certainly favours the view that what can be done will be done, but is this necessarily so? Ought we not to be suspicious when technologists speak of coming developments as automatic, not subject to human control? Is there not something contradictory in the notion that we have the power to control all the untoward consequences of a technology, but lack the power to determine whether it should be developed in the first place?

What will be the likely consequences of the perpetuation of our permissive and fatalistic attitude toward human engineering? How will the large decisions be made? We are fortunate that, apart from the drug manufacturers, there are at present in the biomedical area few large industries that influence public policy. Once these appear, the voice of " the public interest " will have to shout very loudly to be heard above their whisperings in the halls of Congress. These inflictions point to the need for institutional controls.

Scientists understandably balk at the notion of the regulation of science and technology. Censorship is ugly and often based upon ignorant fear; bureaucratic regulation is often stupid and inefficient. Yet there is something disingenuous about a scientist who professes concern about the social consequences of science, but who responds to every suggestion of regulation with one or both of the following: " No restrictions on scientific research," and " Technological progress should not be curtailed." Surely, to suggest that certain technologies ought to be regulated or forestalled is not to call for the halt of all technological progress (and says nothing at all about basic research). Each development should be considered on its own merits. Although the dangers of regulation cannot be dismissed, who, for example, would still object to efforts to obtain an effective, complete, global prohibition on the development, testing, and use of biological and nuclear weapons?

The proponents of laissez-faire ignore two fundamental points. They ignore the fact that not to regulate is as much a policy decision as the opposite, and that it merely postpones the time of regulation. Controls will eventually be called for — as they are now being demanded to end environmental pollution. If attempts are not made early to detect and diminish the social costs of biomedical advances by intelligent institutional regulation, the society is likely to react later with more sweeping, immoderate, and throttling controls.

The proponents of laissez-faire also ignore the fact that much of technology is already regulated. The US Federal Government is already deep in research and development (for example, space, electronics, and weapons) and is the principal sponsor of biomedical research. One may well question the wisdom of the direction given, but one would be wrong in arguing that technology cannot survive social control. Clearly, the question is not control versus no control, but rather what kind of control, when, by whom, and for what purpose.

Means for achieving international regulation and control need to be devised. Biomedical technology can be no nation's monopoly. The need for international agreements and super-

vision can readily be understood if we consider the likely American response to the successful asexual reproduction of 10,000 Mao Tse-tungs.

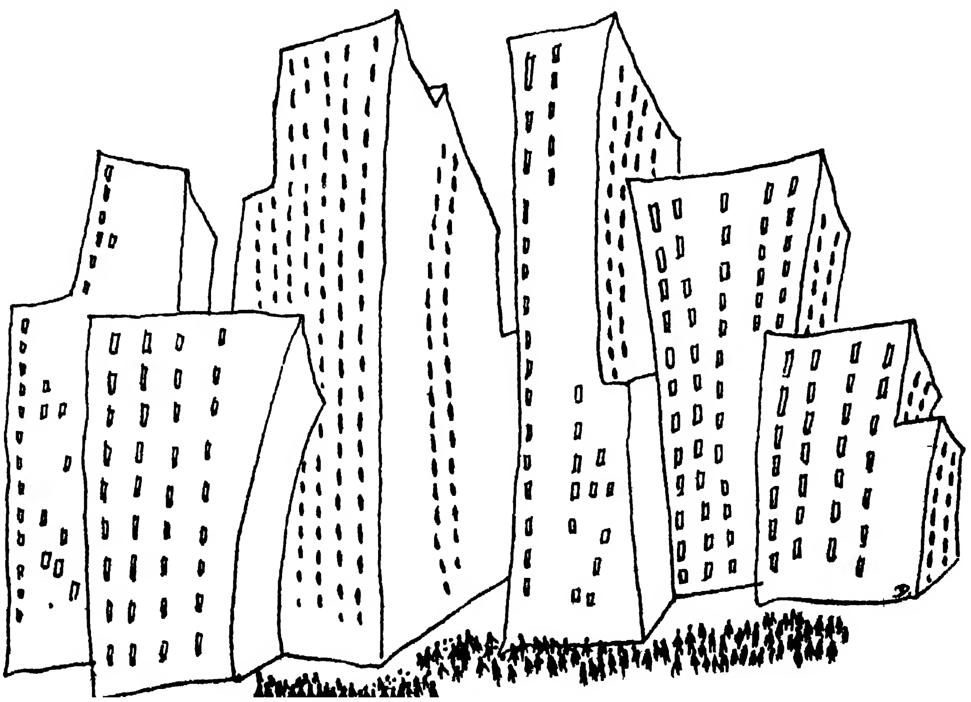
To repeat, the basic short-term need is caution. Practically, this means that we should shift the burden of proof to the proponents of a new biomedical technology. Concepts of " risk " and " cost " need to be broadened to include some of the social and ethical consequences discussed earlier. The probable or possible harmful effects of the widespread use of a new technique should be anticipated and introduced as " costs " to be weighed in deciding about the first use. The regulatory institutions should be encouraged to exercise restraint and to formulate the grounds for saying " no." We must all get used to the idea that biomedical technology makes possible many things we should never do.

But caution is not enough. Nor are cleaver institutional arrangements. Institutions can be little better than the people who make them work. However worthy our intentions, we are deficient in understanding. In the long run, our hope can only lie in education: in a public educated about the meanings and limits of science and enlightened in its use of technology; in scientists better educated to understand the relationships between science and technology on the one hand, and ethics and politics on the other; in human beings who are as wise in the latter as they are clever in the former.

[This article first appeared in *Science*, Vol. 174, No. 4011, 19 November 1971. © 1971 AAAS.].

[When an earlier version of this article was presented publicly, it was criticised by one questioner as being " antiscientific." He suggested that my remarks " were the kind that gave science a bad name." He went on to argue that, far from being the enemy of morality, the pursuit of truth was itself a highly moral activity, perhaps the highest. The relation of science and morals is a long and difficult question with an illustrious history, and it deserves a more extensive discussion than space permits. However, because some readers may share the questioner's response, I offer a brief reply. First, on the matter of reputation, we should recall that the pursuit of truth may be in tension with keeping a good name (witness Oedipus, Socrates, Galileo, Spinoza, Solzhenitsyn). For most of human history, the pursuit of truth (including " science ") was not a reputable activity among the many, and was, in fact, highly suspect. Even today, it is doubtful whether more than a few appreciate knowledge as an end in itself. Science has acquired a " good name " in recent times largely because of its technological fruit; it is therefore to be expected that a disenchantment with technology will reflect badly upon science. Second, my own attack has not been directed against science, but against the use of some *technologies and, even more, against the unexamined belief—indeed, I would say, superstition — that all biomedical technology is an unmixed blessing. I share the questioner's belief that the pursuit of truth is a highly moral activity. In fact, I am inviting him and others to join in a pursuit of the truth about whether all these new technologies are really good for us. This is a question that merits and is susceptible of serious intellectual inquiry. Finally, we must ask whether what we call " science " has a monopoly on the pursuit of truth. What is " truth "? What is knowable, and what does it mean to know? Surely, these are also questions that can be examined. Unless we do so, we shall remain ignorant about what " science " is and about what it discovers. Yet " science " — that is, modern natural science — cannot begin to answer them; they are philosophical questions, the very ones I am trying to raise in the text.]*

When we lack sufficient wisdom to do, wisdom consists in not doing. Caution, restraint, delay, abstention are what this second-best (and, perhaps, only) wisdom dictates with respect to the technology for human engineering



TWA's NEW AMBASSADOR SERVICE. SAME PRICE AS OTHER AIRLINES' ECONOMY SERVICE.

We must admit that other airlines could offer you something like TWA's new Ambassador Service.

All we did was see what our competitors were giving in terms of comfort, meals, entertainment and ground services.

Then worked all year to give you something better.

Sometimes this cost a fortune (we ripped out the insides of all our 707's and renewed everything from the floor up).

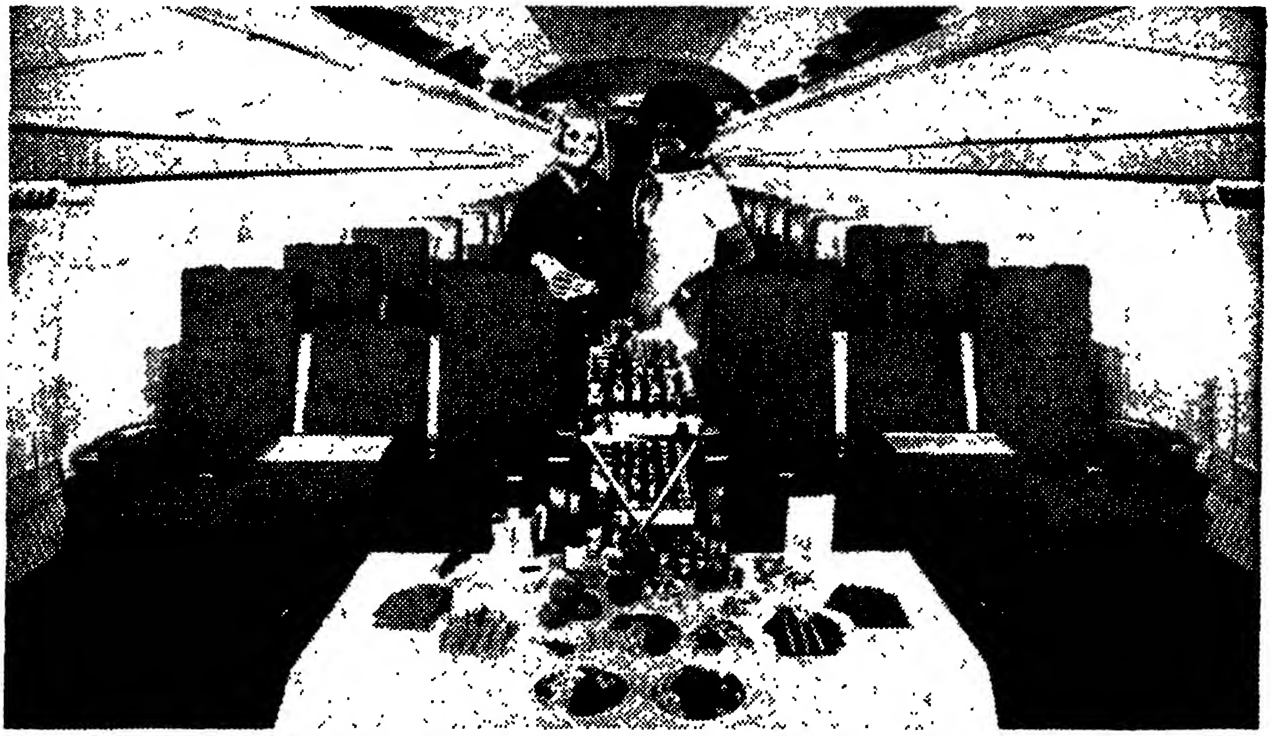
Sometimes this cost a little more trouble (offering a choice of three meals in economy rather than no choice).

And sometimes it cost nothing but a little thought (no-smoking sections, for example).

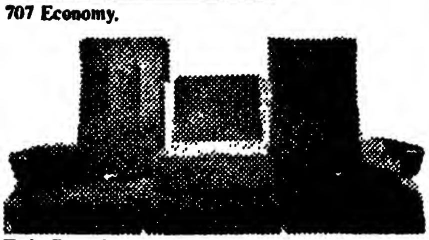
Next time you fly to America, ask your travel agent to book you a TWA Ambassador flight.

If it isn't considerably better than the service other airlines offer you, fly back with one of them.

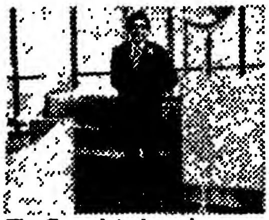
They all charge the same as TWA's new Ambassador Service.



707 Economy.



Twin Seats in economy.
Only TWA gives you this twin seat on 707's in economy. It can be three across, or if the plane's not full, two across or even a couch.



The Ground Ambassador.
Whatever your problems, he'll help you from booking a car to getting a hotel to phoning your office.

New uniforms for hostesses.
We've given our girls a choice of three uniforms (including hot pants) designed by Valentino. It helps.

Choice of three to five meals.
Only TWA offers you a choice of three meals in economy, five in first class.

No smoking sections.
Many Ambassador features cost a fortune. This one just cost a little thought.

TWA's new terminal in New York.
For TWA passengers only. You can be through it, having cleared customs and immigration, inside twenty minutes. Most airlines still share one old terminal.

Choice of films.
TWA offers you a choice of films (one for adults, one for everybody).* Most airlines still show one, or none.

TWA

THE WORLD'S LARGEST AIRLINE SERVING ASIA.

Offices in Bombay • Calcutta • Delhi
Madras • Ahmedabad • Kathmandu

FA.606.72

* IATA requires us to make a nominal charge for in-flight entertainment. And for alcoholic beverages in economy class.

How much double vision?

IN a dimly lit room a pretty girl of 18 was sitting in front of a doctor, who was jotting down something on a sheet of paper. Suddenly he jumped up and switched on the light. The girl had slapped him.

She had seen a fly coming straight at her face and unable to make out its exact position, had lashed out and hit the doctor instead.

The girl was suffering from diplopia or double vision, and the doctor was charting her ailment. The doctor, Dr. A. P. Goswami, Director of the Vision Research Centre, Kanpur, set about devising a more accurate and hazard-free technique of diplopia charting. He has succeeded.

The new technique of diplopia charting uses a specially designed screen on black cloth graduated with black threads in the form of a chart (75 × 75 cm). The chart is divided, by vertical and horizontal lines, into nine main squares (25 × 25 cm), each of these being further divided into 25 small squares (5 × 5 cm). The patient sits on a revolving stool 75 cm from the screen, with his eyes positioned in the centre. He wears diplopia goggles with red glass in front of the right eye, green in front of the left eye. He is given two pointers with black coloured handles and indicators — one red, the other green — fitted at one end at an angle of 110°. He holds the red pointer in the right hand and the green one in the left hand. The object, a white shining piece (8 × 1 cm) of thin plywood, is now hooked in the centre of the upper left quadrant. The patient is then asked to fix his head in a position as if looking at the central quadrant, but is allowed to move his eyes in the direction of the object. If he is suffering from diplopia in this quadrant, he is asked to put the red indicator on the red image and the green indicator on the green image, so as to completely cover the images. The position of each indicator on the screen is charted on a graph paper with red and green pencils. And the same process is repeated in respect of all the nine quadrants.

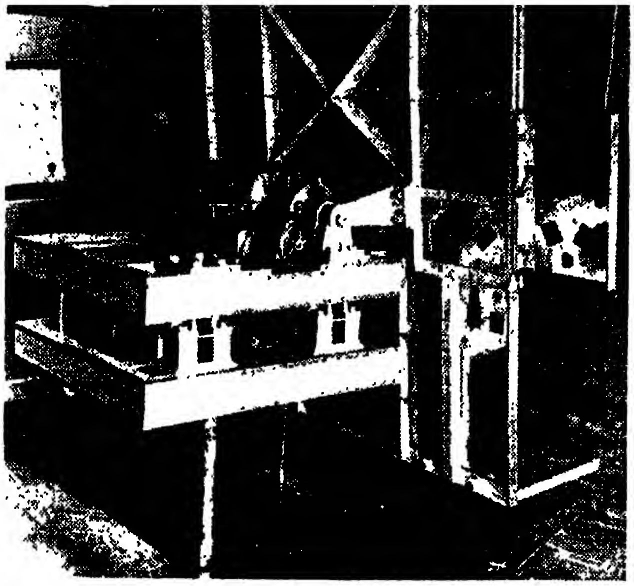
The new technique of diplopia charting makes use of a background screen

In the conventional method, the patient is seated in a darkened room with red and green goggles on. He is instructed to follow an object light called Barlit (a rod of light 4 cm long) without moving the head. The doctor holds the light vertically at a distance of one metre from the patient — first in the centre, then to right and left, up and down, and finally in the four diagonal positions of up-right and up-left, down-right and down-left. The positions where the Barlit is seen as two separate rods (red and green) and also the nature of separations (viz, vertical or horizontal, one image tilted or outwardly displaced, etc) are recorded on a chart with nine main squares marked on it. From this data the doctor determines the degree and nature of the ailment, because the greatest displacement is found in the direction of action of a paralysed muscle.

In the old technique, no background screen was used and the doctor was apt to record wrong positions of the vision displacements indicated by the patient. The new technique eliminates this possibility altogether, and is more exact, simple and economical.

An operation table for animals

SURGICAL operations of animals are often complicated affairs, especially in the case of big animals like the cow or the horse. A suitable operation table which can bear the heavy weight is an important requirement in such



Equine operation table: convenient for vet and animal

cases. The table should also have tilting and sliding arrangements so that the animal is easily laid on it or alighted. Provisions for fastening the animal securely without causing injury and a convenient recess for the doctor to operate are also essential.

Such facilities are sorely lacking in India, though it has a heavy livestock population. An ambulance-cum-operation table for ailing cattle designed by a Poona inventor a few years ago is the best arrangement available now. A more sophisticated universal equine operation table has been now developed by engineers at the Indian Institute of Technology, Madras. Sponsored by the Madras Race Club, and meant specially for horses, the device is easily adaptable for different veterinary surgical treatments.

The main table is 3 m × 2 m in size and weighs about 200 kg. It comprises a 3·5-tonne hydraulic hoist which is run by a 3 hp two-stage compressor. The framework, made of mild steel angle bars covered with thick aluminium sheet, can withstand the full load of a horse weighing up to a tonne. Rectangular slotted and round holes at vantage points on the table are used to fasten the horse securely; two independently mounted square aluminium sliding frames help fasten the head and tail.

The table is brought to the vertical position and the horse is first made to stand on two small platforms perpendicular to the table. After the horse is securely fastened with nylon belts, the table is tilted slowly to the horizontal position. A recess in the table allows the surgeon to operate on the animal. **Badiuddin Khan**

Jute fabrics can now face the light

IT looks as though jute fabrics can still hope to hold their own in foreign markets. A process has been developed which does away with the objectionable yellowing of jute fabrics and enables them to enter the decorative field as wall-covering, drapery and upholstery.

The yellowing of jute, bleached or unbleached, is due to the lignin in it which undergoes photo-chemical changes on exposure to light. Coloured products are formed, which reveal themselves as a marked fading in colour of both bleached and dyed fabrics. These also have surface hair with a high fibre-shedding potential, which makes them still more unattractive.

Over the years, the export of coarse and woven jute fabrics, both hessian and sacking, which are used extensively for packing purposes, has been falling, mainly due to loss of markets to Pakistan and increasing competition from synthetics. Enabling jute products to enter the decorative area, it was thought, might yet help them in international market.

In the new process developed by Dr. A. B. Sen Gupta and Dr. S. K. Majumdar of the Indian Jute Industries' Research Association, Calcutta, lignin is removed from the surface layers of jute fabrics, without appreciably affecting its content in the inner layers, thus maintaining the strength of the material at a satisfactory level. Earlier attempts had failed because indiscriminate removal of lignin, while improving the lightfastness, weakened the fabric, which easily disintegrated during washing.

Jute fabric is treated with chlorine or its derivative in a closed stainless steel jigger under controlled conditions so that the chemical reacts with lignin at the surface layers only. The chlorinated products produced are then extracted from the fabric by treatment with a suitable alkaline reagent. The treated fabric now has four times the lightfastness of an ordinarily bleached fabric, is brown in colour and can be further bleached to a desired shade by the conventional hydrogen peroxide or the hypochlorite method. The resulting fabric also has a very smooth surface and can be used with good effect for making decorative materials like wall-covering, drapery and upholstery.

The new process has been patented in a number of countries including USA, UK, Belgium, Canada and Switzerland. **B. K.**

ARTIST WITHOUT A CANVAS

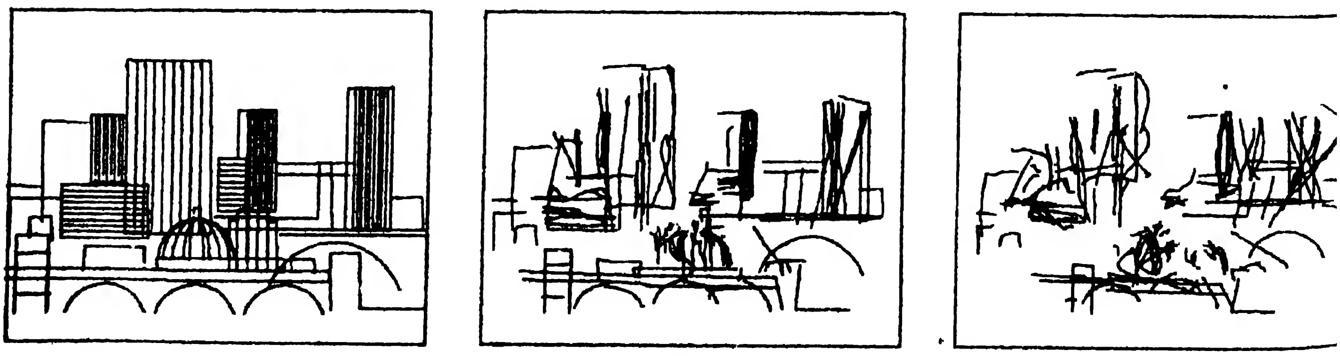
Film Animation Today

EVER since Walt Disney gave it a regal status, animation film making hasn't changed much in technique. It still happens to be the long, laborious process with the animator putting his ideas into thousands of small drawings which, by means of slight progressive changes, are used to simulate motion. Now the National Research Council of Canada has developed techniques which will enable the professional animator skip the tiresome drawing stages. The aid-in-chief is, of course, the computer. The animator can develop pictorial sequences directly on the cathode ray tube display without any knowledge of computer programming.

The animator sits at a display console with a cathode ray tube display, which is very much like a TV set. There are a variety of control devices in front of him — keyboard buttons, knobs, thumbwheel encoders, a light pen and a hand-held positioner called a " mouse ". With these, he draws and manipulates pictures directly on the display screen. A number of separate picture components, each capable of independent motion, may be manipulated

Below : " CHILDREN OF THE WORLD " — a promotional sequence, designed by Philip Quan from the CBC Graphics Department for a network special (Courtesy, CBC)

Below : " CITY TO RUBBISH " — a sequence from Metadata, a National Film Board film by Peter Foldes exploiting the capability of the animation system to interpolate between unrelated pictures. This transformation, which Foldes calls " a significant transformation ", lasts longer than ten seconds on the screen. Six selected frames are shown here



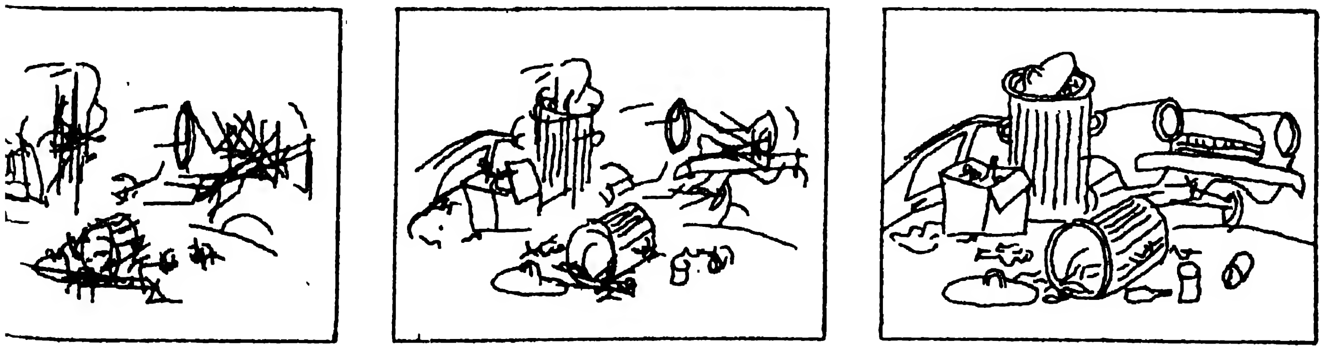
separately as desired and then combined to form a composite picture.

A group of supporting graphic programmes complements the 3-D graphic package. A free-form sketching programme allows the animator to create free-hand drawings. Using the "mouse" to control position, the co-ordinates of selected points may be changed in any direction. In addition, selected parts of an image can be distorted by shaping.

The technique of key-frame animation involves the creation by the animator of isolated frames at key intervals during a sequence, with the in-between frames to be computed by interpolation. Starting with a script and a story board, the series of key sketches that will progressively depict the action must be planned. These keys will include the extremes of all movements, since they will be used as the terminal points for interpolating the in-between frames. Once all the key frames have been established, the animator can begin preparing his picture components or cels by sketching the images directly on display. As these picture cels are created, they are saved in the disc library for use at a later time. Each picture cel is interpreted as a 3-D shape that may be scaled, rotated and positioned as required. A composite cel for a key frame may be assembled by overlaying a number of individual picture cels. Pictures for subsequent key frames may be partially or completely redrawn, or alternately, may be derived by modification of existing pictures using one of the distortion routines. ■ ■

Nestor Burtnyk, an engineer in NRC's Radio and Electrical Engineering Division, uses the Data Systems Section computer graphics facility to develop some of the images which appear on the title design

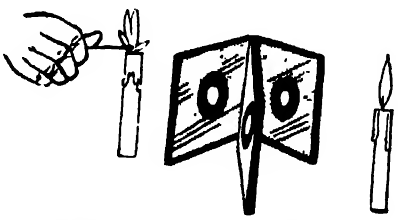
Selected frames of a walk sequence. There are five key frames per cycle of the walk. Each key frame consists of three cels



LOOKING BACK . . .

Did the stars foretell ?

ROBERT BUNSEN (31 March 1811): Even those who have a nodding acquaintance with chemistry will remember the Bunsen burner. The credit for inventing this gas burner, which draws in air through a hole at the bottom of a tube so that the resulting gas-air mixture produces a smokeless, intensely hot flame, is generally given to Robert Bunsen. The credit is however somewhat misplaced, for he got the idea from a similar burner used by Faraday, and the design from his mechanic. However, since this burner played a great part in Bunsen's epoch-making work on chemical analysis, this mix-up is quite natural.



Grease spot photometer, an invention of Bunsen

Bunsen's greatest invention, though, was the spectroscope, a great deal of the credit for which should go to his co-worker Kirchhoff. The spectroscope, essentially a glass prism and a telescopic apparatus, breaks up light into its component colours. It paved the way for the growth of spectroscopy in which elements are identified by the characteristic colours and lines they emit when heated to the point of incandescence. It was by spectrum analysis that elements like caesium and rubidium were discovered. Helium was first discovered by studying the sun's spectrum. Later, this technique led to the emergence of astrophysics which deals with the physical states of stars.

Bunsen's interests in inorganic chemistry were varied. He studied the gases produced in blast furnaces and suggested methods for cutting down heat loss. On the theoretical side he put forward a basic principle of organic chemistry that the nature of organic chemical compounds depends upon the organic radicals of which they are made. His work greatly helped the development of industrial chemistry.

Though he lived till 1899, Bunsen never married, on the ground that he did not have the time for marriage.

RENE DESCARTES (31 March 1596): There is some story or other associated with great scientists, and often their big ideas come to them when they are not actually concentrating on their work. The story associated with René Descartes' co-ordinate system — his most important contribution to science — is that he was one day watching a fly hovering in the air and it occurred to him that the fly's position could be described at any moment by locating the three mutually perpendicular planes that intersected at the position occupied by the fly. On a two dimensional surface, every point could be located by means of two mutually perpendicular lines intersecting at that point.

Descartes saw that through the use of this co-ordinate system every point in a plane could be represented by marking off units on a horizontal line (*x* axis) and a vertical line (*y* axis), the former standing for distance in one plane and the latter for distance along the other. Thus, any geometrical figure on the paper could be represented by a set of numbers. Rules were also

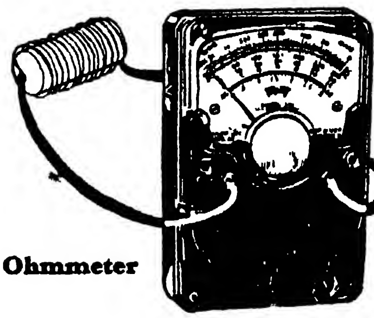
worked out for addition, subtraction, multiplication and division with ordered pairs of numbers, and so, geometry could be done in the same way as algebra or arithmetic. These pairs of numbers were later called " co-ordinates " and the new mathematics of Descartes' " co-ordinate " or " analytical " geometry later enabled Leibnitz and Newton to invent calculus.

Descartes' place in science is due to his devising a method to link algebra with geometry. He is also considered to be the father of modern philosophy. He was a mechanist. His name is now associated with the phrase "Cogito ergo sum " (" I think, therefore I am"). Descartes died on 11 February, 1650.

GEORGE SIMON OHM (11 March 1787): A quarter century after his death in 1854, the International Congress of Electrical Engineers meeting at Paris decided to name the unit of electrical resistance after George Simon Ohm. Ohm's name spelt backward is also commemorated in the unit of conductance (or the reciprocal of resistance) — the mho.

Son of a professional, though well-read, locksmith of Cologne, Ohm was ignored by his countrymen. Fortunately, he was recognised in France and England.

Influenced by Fourier's work on the flow of heat through thermal conductors, Ohm established that there is a simple relationship between the strength



Ohmmeter

or intensity of an unvarying electrical current, the electromotive force and the resistance of a current. The law he discovered has come to be called Ohm's law and can be expressed: " the flow of a current through a conductor is directly proportional to the potential difference and inversely proportional to the resistance." Ohm died on 7 July 1854.

PIERRE SIMON LAPLACE (28 March 1749): Recently it was reported that a tenth planet, named Vulcan, had been discovered in space, beyond the orbit of Pluto which was hitherto thought to be the outermost member of the Sun's family. The new planet is believed to have been detected by the perturbations or irregularities it was causing in the motion of Pluto.

That was how, in fact, Neptune had been discovered in the last century. The man who first used the method was Pierre Simon Laplace who in 1787 showed that the slightly faster motion of the Moon was due to the slight change in the shape of the Earth's orbit as a result of the gravitational influence of other planets. The anomalies in the motions of Jupiter and Saturn, he also showed, were due to gravitation influence of one planet upon another.

Laplace however is best known for his speculation about the origin of the solar system. Called the Nebular Hypothesis, this postulates that there was originally a rotating mass of gas. As it contracted, its rotation speeded up and an outer ring was thrown off, to condense later as a planet. This was how the planets were formed. The Sun itself was formed by the condensation of the core of the nebula or gas-cloud. The Nebular Hypothesis has survived to this day in various forms. The philosopher Kant had earlier worked out a similar theory, though not so thoroughly. Though not fully borne out by facts, its basic idea of the natural origin of cosmic bodies by the condensation of cosmic gas or dust has not lost its import.

Laplace was a versatile man and dabbled in politics too. He became a minister under Napoleon and survived his fall. In 1817 he became president of the French Academy. He died on 5 March 1827.

J. B. PRIESTLEY (13 March 1733): The son of a country weaver, orphaned before the age of seven, with no schooling, J. B. Priestley was an amateur scientist whose interest in chemistry was perhaps fired by the colourless gas he noticed coming out of the fermenting vats of a brewery near his house. He found that this gas could extinguish burning wood chips, and on dissolving in water gave a pleasant taste to it. The gas was carbon dioxide, now extensively used in the soda-water industry.

With the " sodawater " success, Priestley's interest in gases grew.

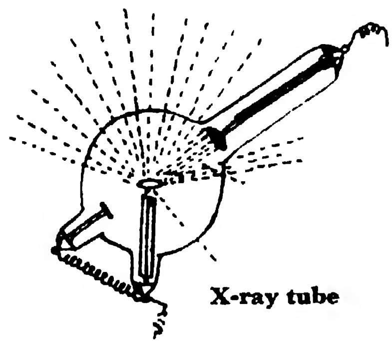
One day he noticed that mercuric oxide on being heated gave off an invisible gas with remarkable properties. Burning objects burnt more brilliantly in it than in air. The gas was similar to that portion of air which was used up in burning. It was oxygen, vital to animal and vegetable life. Priestley called it " dephlogisticated air ", and owing to his blind faith in the phlogiston theory according to which air is indivisible, he failed to appreciate the importance of his discovery. (As a matter of fact, the German chemist Scheele had discovered this gas a couple of years earlier, but because his findings were not published, Priestley got the credit for the discovery.)

Priestley was a radical in politics, a liberal in religion and a conservative in science. His sympathy for the French Revolution brought down upon him the wrath of his countrymen and he was obliged to flee to America. He died in 1804.

WILHELM KONRAD ROENTGEN (27 March 1845): On 5 November, 1895 a German scientist working in a darkened room with a cathode ray tube covered with thin black cardboard noticed that when the tube was switched on, a sheet of paper coated with barium platinocyanide in the distance was glowing. He knew, of course, that when rays from the cathode (negative electrode) of the tube struck the glass end of the tube near the anode (positive electrode) they produced a strange green fluorescence. But these rays could not travel through glass or cardboard. Hence the scientist, Wilhelm Konrad Roentgen, knew that the rays exciting fluorescence in the paper sheet must be of an invisible and great penetrating nature.

Since he did not know the exact nature of these rays,

he called them " X-rays ", by which name they are still known. The fact that the rays could penetrate flesh and were stopped by bone was made use of in medicine for producing " shadow pictures " of various parts of the body. A bullet imbedded in the flesh could be located with a X-ray photograph.



X-ray tube

When the Nobel Prizes were set up in 1901, Roentgen was given the first award for physics. Roentgen died on 10 February 1923, of cancer, a disease which can now be treated with X-rays.

S. N. Munshi

THINGS WE USE

Elevators

SUMATI K. SAMPEMANE

THE door slides open. Passengers walk in, pressing buttons for their respective floors. A newcomer requests ' Fifteenth floor please '. A co-passenger tells him this particular lift goes only up to the thirteenth floor. That means getting into another elevator at the thirteenth floor. He suddenly remembers a friend on the sixth floor. Deciding to call on him he requests to be dropped there. "But sir ! This lift doesn't halt before the thirteenth floor." So up he goes to the thirteenth floor wondering " Why are there fast elevators like there are fast trains? "

In India, where buildings are just beginning to scrape, or rather brush, the sky, fast lifts are just coming into the field. High-speed lifts here travel at a speed of 213 metres per minute. In the 100-storey skyscrapers of the west a speed of 610 metres per minute is not rare.

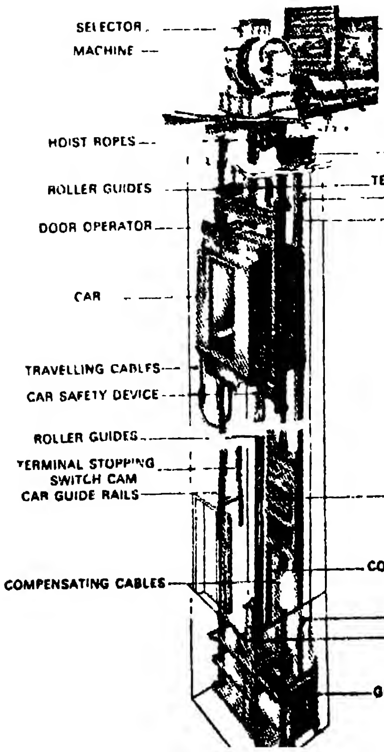
Elevators are not a modern invention. Archimedes is credited with having constructed a lift around 200 BC. Though, in principle, it resembled to a certain extent the lifts which were to come centuries later, the difference lay in the power it utilised — manpower. Then came the hydraulic lifts of the seventh century. It was only after 1850 that elevators were developed and steam, electro-hydraulic and electric elevators were used along with the hydraulic-powered ones. Most modern lifts are electricity-driven.

Basically, there are three types of elevator machines — the hydraulic, the drum type and the traction machine. In the first, the elevator car is mounted atop a piston and is raised or lowered by adjusting the pressure of the liquid inside the cylinder inside which the piston moves. Such elevators are hardly ever used in modern buildings.

The drum type, another machine that is becoming obsolete, consists of a winding drum to which the hoist ropes are fastened. The drum is driven by a machine and the counterweight ropes are also attached to it. As the drum revolves, unwinding the elevator car ropes, the counterweight ropes get wound in the same grooves. When the counterweight ropes unwind, the car ropes are wound. Thus when the car goes up the counterweight comes down and vice versa. Such machines cannot be used in many buildings as there is a limit to the drum size and also to the height of ascent — 50 metres or less. (See figure on p. 58.)

In the third type, the traction machine, the car is moved by the friction between the hoist ropes and the grooves of the traction sheave. One end of the hoist ropes is attached to the elevator car. The other end, passing over the sheave, is connected to the counterweights. There are two types of traction machines (p. 58). In the single traction machine, the ropes pass over the sheave only once. In this case, since the contact between the groove and ropes cannot be more than 180° under any circumstances, the grooves are V-shaped to give a pinching action to the rope to increase traction and also to prevent slipping. In the double-wrap traction machine, the rope passes over the traction sheave (or drive sheave), onto a secondary sheave and back to the first, thus increasing the area of contact and the traction. Double-wrap traction is used for high-speed elevators. The elevator works on the principle of a simple pulley using a grooved sheave to change the direction of force. This is called 1 to 1 roping. The 2 to 1 or 3 to 1 roping used for freight elevators works on the principle of multiple pulleys. They reduce the climbing speed but increase the load-lifting capacity. (See figure on p. 59.)

Traction machines may be geared, with the movement being transferred to the drive sheave through a worm gear. In the gearless type, the drive sheave is attached directly to the motor



PASSENGER ELEVATOR

Typical installation gearless machine

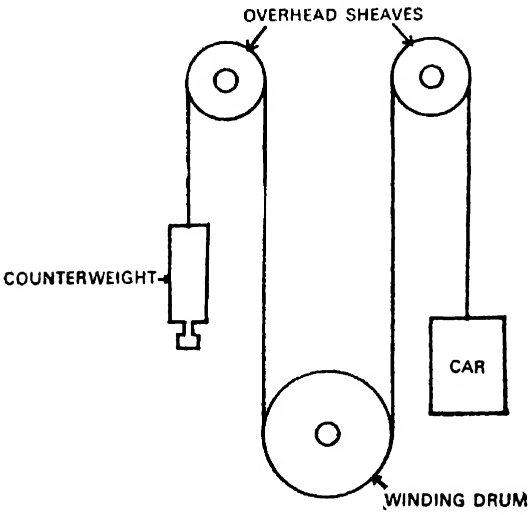
shaft. These are the most commonly used machines for high-speed and high-rise elevators.

The weight on the drive sheave when the elevator car is moving upwards is reduced by balancing the weight of the car with a counterweight which is equal to the weight of the car + 40 per cent of the full load it can carry. While on the downward journey, the counterweights check the speed of the car. Counterbalancing the car alone is not sufficient as the weight of the hoist ropes is also of consequence. Ropes running from the base of the car and/or counterweights attached somewhere at the midpoint of the elevator shaft is one solution. Another is connecting a chain from the base of the car to the base of the counterweight. But this is a noisy affair when speeds go beyond 150 m.p.m. Yet another method consists of using one set of ropes from the base of the car joined to the base of the counterweight over a sheave. The weight of the compensating ropes is equal to the weight of the hoist ropes.

The early elevators were manually operated. The operator had to stop, open the doors and secure them before continuing the journey. Levelling with the landing was another serious problem which involved slackening the speed very much in advance and inching up to floor level. This not only increased the wear on the rope but also increased power consumption in addition to losing valuable time.

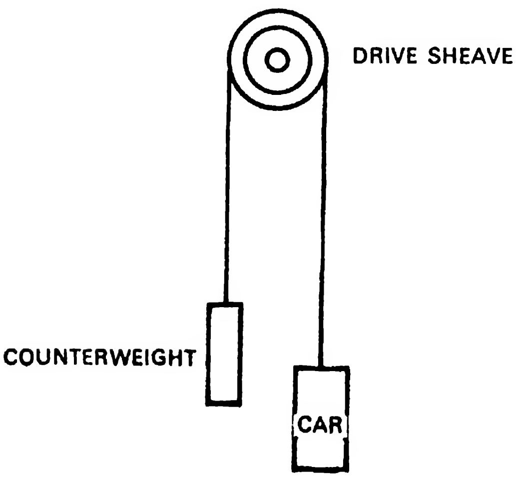
Once the elevator is full and starts on its journey its speed is controlled by a varying voltage. Resistances are cut off thereby increasing the current and consequently the speed. The stopping is automatic. When the operator presses the button for a particular floor it is recorded by the selector. The selector system is very much like a mini elevator. It consists of a travelling cross head driven vertically on a screw. A steel tape which connects it to the elevator car is wound on sheaves at the top of the hoistway. The tape sheave and the vertical screw (on which the cross head moves) are connected by a chain drive and reduction gears. Pressure on any button in the car energises a stationary contact on the selector. So when the corresponding floor is reached, the cross head brushes pick up the signals and indicate the controller to stop. The resistances are reintroduced and the elevator is brought to stop at that floor.

Many devices were developed to slow down the car within inches of a landing to get a perfect levelling. Still it was not wholly electronically managed as today and there were always bound to be small differences in levels. High-speed lifts with solid non-see-through doors have made automatic landing a must. Electronic control devices have stepped in. The



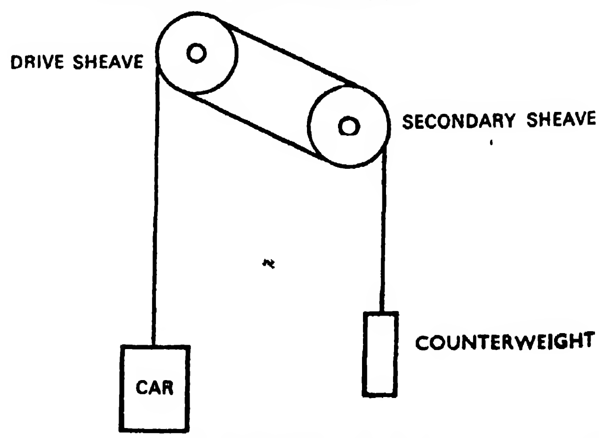
DRUM TYPE ELEVATOR

SINGLE WRAP TRACTION MACHINE

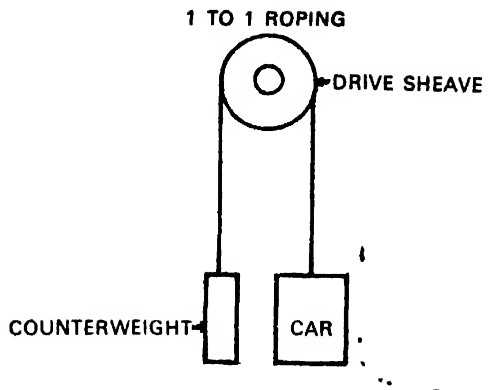


THE ELEVATOR MOVES DUE TO THE FRICTION BETWEEN THE HOIST ROPES AND THE GROOVES OF THE SHEAVE. IN A SINGLE WRAP TRACTION MACHINE THE AREA OF CONTACT BETWEEN THE TWO CANNOT EXCEED

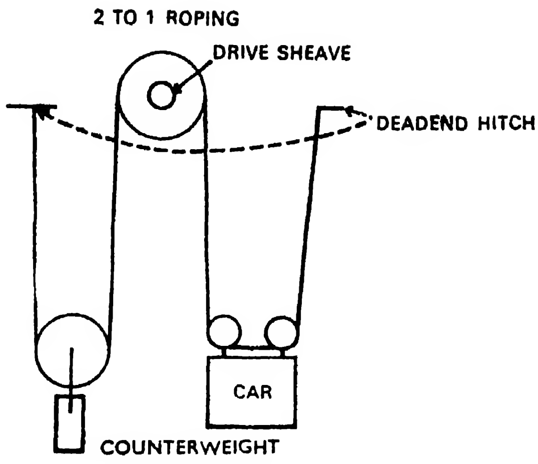
DOUBLE WRAP TRACTION MACHINE



THE DOUBLE WRAP TRACTION MACHINE INCLUDES A SECONDARY SHEAVE OVER WHICH THE ROPES PASS BACK OVER THE DRIVE SHEAVE THEREBY INCREASING THE AREA



THE SPEED REMAINS UNHAMPERED. ONLY THE DIRECTION OF FORCE IS CHANGED



THE SPEED OF THE CAR IS REDUCED BY HALF BUT ITS LIFTING CAPACITY IS NEARLY DOUBLED

pressing of a button at a landing or in the elevator car indicates to the operator that a stop should be made at that floor and signals to him when to centre the car switch. A pressed button remains pressed, indicating that the call is to be answered and as the car approaches the floor a signal is flashed to the operator. In some elevators, when a button is pressed in the car or at a landing, a stopping zone is established and, as the car enters this zone, it slows down. The operator centres the switch, the car stops and the doors open. One step further, in certain lifts the operator's only job is to start the car after which it goes to its first stop as signalled. Stopping in level with the floor, the car and hoistway doors open as it comes to a halt. When the car is full it can bypass a call by the pressing of a switch on the car panel. The call is automatically transferred to the next car. As a safety measure, some elevators automatically bypass a call when their load crosses a certain limit. This prevents overloading. The pressed buttons in the car panel, registering the floors at which it should be stopped, remain in position till the car slows down at the terminal landings. They are then released in order to register calls in the opposite direction. A collective control for all elevator cars distributes the load effectively so that travel can be accomplished in minimum time. If one car is full its calls are automatically transferred to the next car journeying in that direction.

To prevent the doors from closing and injuring passengers while they are entering or leaving, many elevators are installed with photo-electric tubes. These keep the passengers from getting hit by the closing door. A slight pressure (as in magnetic designs on the door edge) or an interruption in the path of the light beam or electric field (as in photo-tube protection and the cathode cold tube) is enough to make the doors reopen. If, however, the obstructions are placed in its path again and again in the case of the photo-tube and cathode cold tube protections, the protective devices get switched off after a predetermined interval and the doors begin to close slowly trying to nudge out the obstacle.

Freight elevators are quite similar to passenger elevators. But they are comparatively slower and have greater loading capacity. They are mainly driven by geared traction machines or, if gearless traction machines are used, with 1 or 2 sheaves. It is mainly in the elevator car that they differ from passenger elevators. Freight cars are sturdier and can take heavy thrusts while loading or unloading. Accurate levelling is even more important for freight elevators as articles must be loaded and unloaded with minimum shock. (So also is the case with hospital elevators where it is essential to carry the patients with minimum jolts. Such elevators in residential buildings are smaller and are meant for lighter loads.)

When riding an elevator one does wonder occasionally what would happen if the hoist ropes gave away? Firstly, the elevator is mounted on 12 ropes, each of which can carry a little more than the weight of a fully laden lift. A serious accident occurs only when all the elevator twist ropes (there are usually six of them) and the governor ropes give way. This is extremely rare. Ropes giving way is a remote possibility as they are checked often and all of them are changed even if a single one is slightly damaged. Rarely do carbon steel ropes go unchanged for more than 6 to 8 years. If an elevator starts accelerating down unexpectedly, the safety speed governors cut off the current and stop it. In case this measure proves ineffective and the speed crosses 40 per cent in excess of the predetermined speed, the governor brings into action the safety clamps (which are below

The Death Lifts!

TWO years ago a fire broke out in an office block in New York City, USA. Two of the building's lifts stopped at the blazing floor. One got jammed and two of its occupants died. The other descended to the ground floor. That set off a controversy. It was suggested that lifts might carry passengers to a fire because certain electronic call buttons are triggered by flame. But the lift industry vehemently fought the suggestion.

The lift call button around which the controversy centred is the type that is activated by the proximity of the finger. It has no mechanical parts. It is a cold cathode tube operating at a voltage close to its breakdown point. When a finger is applied to the button, the body's capacitance is added to the circuit. The voltage in the circuit is altered, the tube is discharged and the lift is thus called. These buttons are not, however, heat sensitive and are not triggered by the heat of the finger as is commonly believed.

But Thomas G. Lee of the National Bureau of Standards (USA) tried a simple test. He held a burning match so that the flame touched the button. Sure enough the button was triggered without suffering any damage. The elevator industry agrees that flame can trigger a lift because flame, like the human body, is an electrical conductor and affects the call button circuit. But they argue that in the early stages of a fire it is hardly likely that flames can come in contact with the button. Lee feels otherwise and thus the controversy rages.

In justifying the safeness of the button the elevator industry unwittingly let the cat out of the bag. They said all buttons may be dangerous in fires. In one test on both cold cathode and mechanical buttons, the buttons were subjected to high temperatures. At 250°C the insulating material burnt away thus causing a short that registered a call signal for the lift. These temperatures are fatal to human life. But, in such cases, in all probability the lifts itself and the lift shaft would be too damaged for the lift to operate. But in fires, temperatures zoom as high as 750°C.

Another bone of contention is the electronic eye photodetector-system that keeps lift doors open. It was found that smoke on a blazing floor could block light to such a device and keep the lift door open. If as little as 21 per cent of the light is blocked the door remains open. Some lifts have additional safety devices — the force-close devices that override the detector after about 30 seconds. But many such devices are defective. However, smoke from cigarettes does not prevent the closing of the door.

In the face of such evidence is there anything being done to make the lift a safe device? Countries like France have stringent rules — each floor must have a lift lobby that is automatically isolated in the event of a fire. Also, all lift buttons used must have fusible links that disconnect the button at 70°C. New York City plans that each lift should have a smoke or heat detector on its ceiling to despatch the lift to the ground floor when activated. Other protective devices are available. But if no action is forthcoming it will only be a matter of time before a lift somewhere in a burning building carries its passengers on a ride to death.

the elevator car) to grip the guide rails and slide the car to a halt. The clamps hold the position till the fault is located and rectified. They can be released by taking the car up for a short distance. In buildings where basements are used, the counterweights also have speed governors. Other safety devices include the immobility of the elevator till the landing doors of all floors and the car door are firmly shut. There is an alarm button in each car and modern buildings also provide elevators with an intercom system. Total elevator accidents are 0·01 per cent of automobile accidents. There has been only one fatal accident in 4·6 million travels according to a study of American accidents.

Unfortunately, in case of a fire, the most effective means of travel from the building tops cannot be used as the main switch has to be shut off. In such cases fire-escape stairways are the only way out. However, some buildings have fire-escape lifts situated well outside the building and separated at each floor by a fireproof door.

What will elevators of the future be like? Double-decker elevator cars have come into use for passenger cars. Here the lower deck serves the even floors while the upper deck serves the odd floors. All a passenger need do if he gets into the wrong deck is walk up or down a floor to his destination. Such elevators certainly promise to melt the long queues in skyscrapers faster.

ELECTRIC HARMONIUM

THIS little gadget is for the more musical minded. You might call it an electric piano or an electric harmonium. It costs little and would cost even less if you have a mains AC radio at home.

There is just one valve in the entire circuit — ECC 83, a double triode valve. This versatile valve will give you a range of tones if it is arranged in the way shown in the circuit diagram. In the first triode, an inter-stage audio transformer of the ratio 1 : 3 is used in the plate circuit. The grid has eight 25K ohms variable resistors. As you press the various switches (which could be made from the keys of a toy piano) various values of the resistors will work as the grid leak. Thus each will give a different tone. You can set the variable resistors by starting with the one nearest the grid and proceeding from there. If possible get the help of a musician to set the values to give tones equivalent to the notes on the musical scale. Otherwise you can try it by ear. The first triode acts as an oscillator, the second as an amplifier.

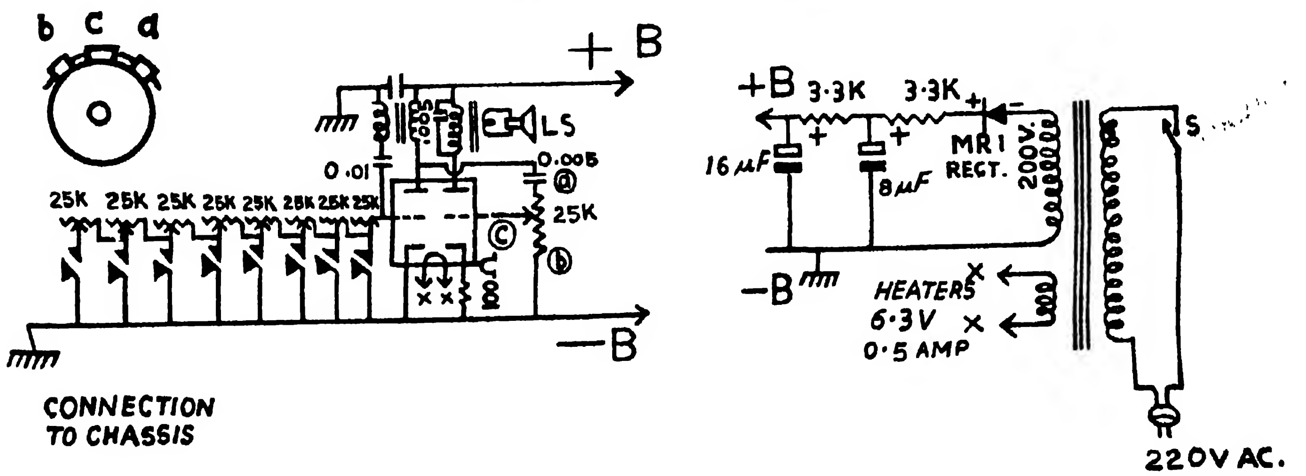
The power supply device consists of a mains transformer, a rectifier and a filter circuit. The power can even be obtained from an AC radio set. A contact-cooled rectifier (MR1) is capable of supplying sufficient current for a single ECC 83 valve. The small mains transformer will have a primary of 220–0 volts and a secondary of 0–200V, 20 mA and 6·3 volts, 5 amp. Two electrolytic capacitors of 16 mfd and 8 mfd are employed in the filter circuit. To get a better tone you can use a hi-fi amplifier by connecting the input of the amplifier with the ends (point a and b) of the volume control switch.

You will need:

Resistors: Variable resistors, 25K ohms each, 8 pieces; volume control, 250K ohms with on/off switch; 3·3K ohms, 2 pieces; 100 ohms, 1 piece. *Capacitors:* 0·01 mfd, 250V, 2 pieces; 0·005 mfd, 250V, two pieces; 16 mfd, 350V, electrolytic, 1 piece; 8 mfd 350V, electrolytic, 1 piece. *Valve:* ECC 83 (made in India by B.E.L.). *Rectifier:* MR1, contact-cooled rectifier, 250V, 20mA. *Transformers:* T1, interstage audio transformer, ratio 1 : 3. T2, small output transformer to suit loudspeaker. T3, mains transformer, primary to suit mains, secondary 200V, 20mA and 6·3V, 0·5 Amp. *Miscellaneous:* Loudspeaker, chassis, screws, wires of different colours, knobs, piano switches, suitable cabinet, etc.

A. Prasanna

The circuit diagram of the electric harmonium



QUESTION & ANSWER

Why does the speed of sound vary?

SOUND travels faster through dense substances like water or steel than through air; yet it travels faster in warm air than in cold air, and warm air is less dense than cold air. Is this a paradox?

What our ears detect as sound is caused by a vibration that brings about an oscillating movement in the atoms or molecules making up the medium through which sound travels. The vibration pushes nearby molecules together, compressing them. The compressed molecules move apart, bringing about a compression in a neighbouring region, so that the area of compression seems to travel outwards from the sound source. The speed at which the wave of compression moves outwards from the source is the speed of sound in that medium.

The speed of sound depends upon the natural speed with which the molecules making up a substance move. Once a particular section of air, for instance, is compressed, the molecules move apart again because of their natural random motions. If this random motion is fast, the molecules of the compressed section move apart quickly and compress the molecules of the neighbouring section quickly. The neighbouring section also moves apart quickly and compresses the next section quickly. On the whole, then, the wave of compression moves outwards quickly and so the speed of sound is high.

Anything which increases (or decreases) the natural speed of the molecules of air will increase (or decrease) the speed of sound in air.

As it happens, air molecules move more rapidly at higher temperatures than at lower ones. For that reason sound travels more rapidly through warm air than through cold air. This has nothing to do with density.

At 0°C, the freezing point of water, sound travels at 1,195 kilometres per hour. This speed goes up about 5·63 kilometres per hour with each Centigrade degree rise in temperature.

Generally, gases made up of lighter molecules than those of air are less dense than air. The lighter molecules also move more quickly. The speed of sound through such light gases is faster than in air, not because of any change in density, but because of the faster motion of the molecules. Sound travels at 4,666 kilometres per hour in hydrogen at 0°C.

When we come to liquids and solids, the situation is quite different from that in gases. In gases, molecules are very far apart and scarcely interfere with each other. If molecules are pushed closer together they move farther apart through random motions only. In liquids and solids, however, atoms and molecules are in contact. If they are pushed together, their mutual repulsion forces them apart again very quickly.

This is especially true of solids, where atoms and molecules are held more or less rigidly in place. The more rigidly they are held, the more rapidly they spring back when pushed together. For this reason, sound travels more rapidly through liquids than through gases; still more rapidly through solids; most rapidly through rigid solids. Density is not the basic reason.

Thus, sound travels through water at a speed of about 5,310 kmph and through steel at a speed of about 17,699 kmph.

Isaac Asimov

How are rainbows produced?

THE arcs of colour we see in the sky occur when sunlight illuminates falling raindrops. The drops of water act like glass prisms, splitting light into its primary colours. Sometimes, several bows are seen at the same time. Parallel rays of light strike a water droplet and are refracted on entering the drop, then reflected from the interior surface, and refracted as they emerge. One ray leaves the droplet at the smallest angle of deviation from the original direction of the rays. This ray of minimum deviation has the greatest intensity and visibility. Since the angle of deviation for such a ray is smaller for the red light and larger for the blue, the rays of minimum deviation from many

water drops of the same size are seen as an arc of colours, with red on the top and blue on the bottom. In a secondary rainbow, which is larger and fainter, the order of the colours is reversed. In this case, two internal reflections occur in each drop of water. Two people standing near each other don't see exactly the same rainbow. Rays of light are passing through raindrops all through the sky, and a person focuses on only one, or one series.

The shape of a rainbow is not an arc because the earth is round. The rainbow is curved because each colour is formed by the angle at which the reflected rays reaches the observer, and this angle remains constant for the same colour.

A person can never reach the end of the rainbow, because when he moves, the rainbow moves also. Seeing the rainbow rest on the horizon is only an optical illusion. Usually, at least half of the rainbow is below the horizon. From airplanes or high mountains a rainbow may be observed as a complete circle.

Rainbows are best seen in early morning or late afternoon. Although the colours produced are the same primary colours produced when a beam of white light is broken up by a glass prism, few people distinguish all seven colours. There is considerable overlapping, and the colours near the blue end of the spectrum are often faint. The number of colours and their relative widths in the rainbow vary with the size of the raindrops. Most people see bands of red, yellow and bluish-green.

"Buckminster Fuller, I presume."

Solutions to Last Month's Brain Teasers

The mixed-up boat race

1. Bullet belonged to Shyam. This is how it's worked out. Sarasa cannot belong to Pathak or David as David's boat is Vijaya and Sarasa is used by Pathak in the second event, his boat being taken by Shyam. Hence Sarasa must belong to either Ram or Shyam. Ram can use only Vijaya for the second event and Pathak's boat for the third. So Sarasa obviously belongs to him. David won the fourth event in Arrow. He obviously used Sarasa for the first event and Bullet for the second one. Therefore, Bullet must belong to Shyam and Arrow to Pathak. The complete breakdown of the four events will be as follows:

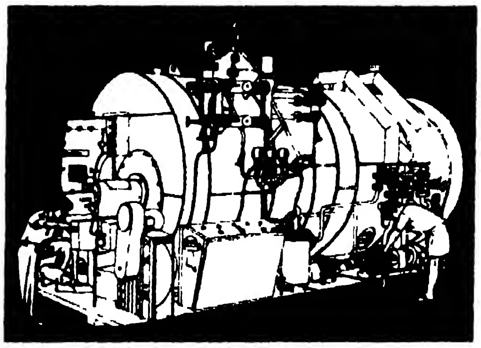
	Ram	**Shyam**	**Pathak**	**David**
First	Bullet	Vijaya	Arrow	Sarasa
Second	Vijaya	Arrow	Sarasa	Bullet
Third	Arrow	Sarasa	Bullet	Vijaya
Fourth	Sarasa	Bullet	Vijaya	Arrow

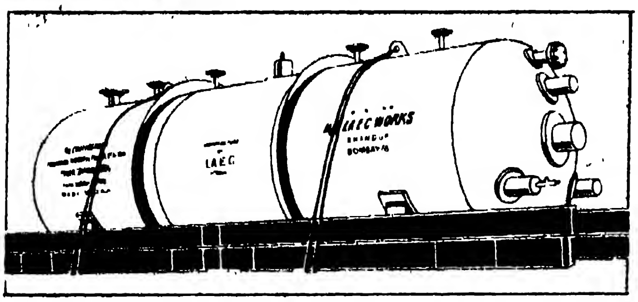
Who Sat Where?

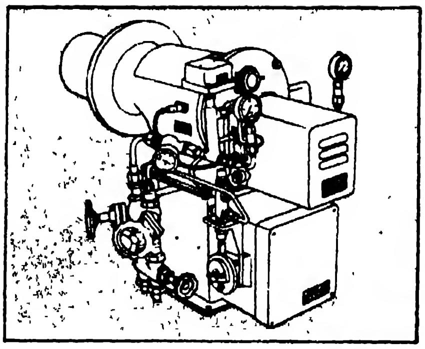
2. The six girls could sit around the table in 120 different ways. But we do have clues.

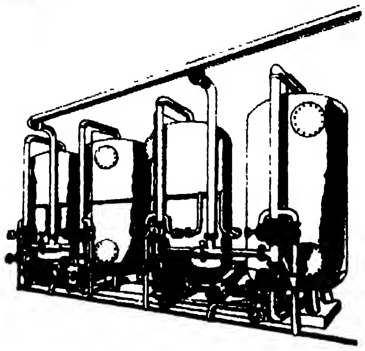
Starting with Asha. If she is correct, Leela and Sheela are wrong. What Maya said contradicts the words of both Radha and Jaya. So, if Asha is right, three girls and not two are wrong. That means Asha is one of those who remembered incorrectly. Similarly, we can conclude that Maya was also wrong. So Leela, Radha, Sheela and Jaya remembered correctly. Based on what they said, we can work out the seating arrangements as follows, starting from Radha and proceeding in a clockwise direction: Radha, Asha, Sheela, Leela, Mala, Jaya.

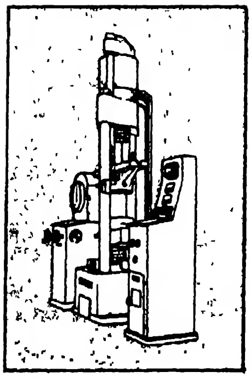

PROFILE OF A
PANAMA
PATRON
He loves things Indian, things truly Indian.
A discerning smoker, and a demanding one too, he revels in the goodness and richness of Panama. He knows full well that his Panama is expertly blended from fine Indian Virginia tobaccos and its quality is jealously guarded.
Now tickle him a little. He waxes with patriotic fervour and proclaims that Panama is India's own, his own and your own too. He never allows himself to be lured away by any parade of international brand names claiming foreign ownership. With a commendable courage of conviction he patronises Panama and always hails it as the pride of the Indian cigarette industry.
Panama
20
CIGARETTES
GTC
GOLDEN
Golden Tobacco Company Limited, Bombay-56
WHOLLY INDIAN—
OWNERSHIP • CONTROL
MANAGEMENT • KNOW-HOW
GT (P)-704









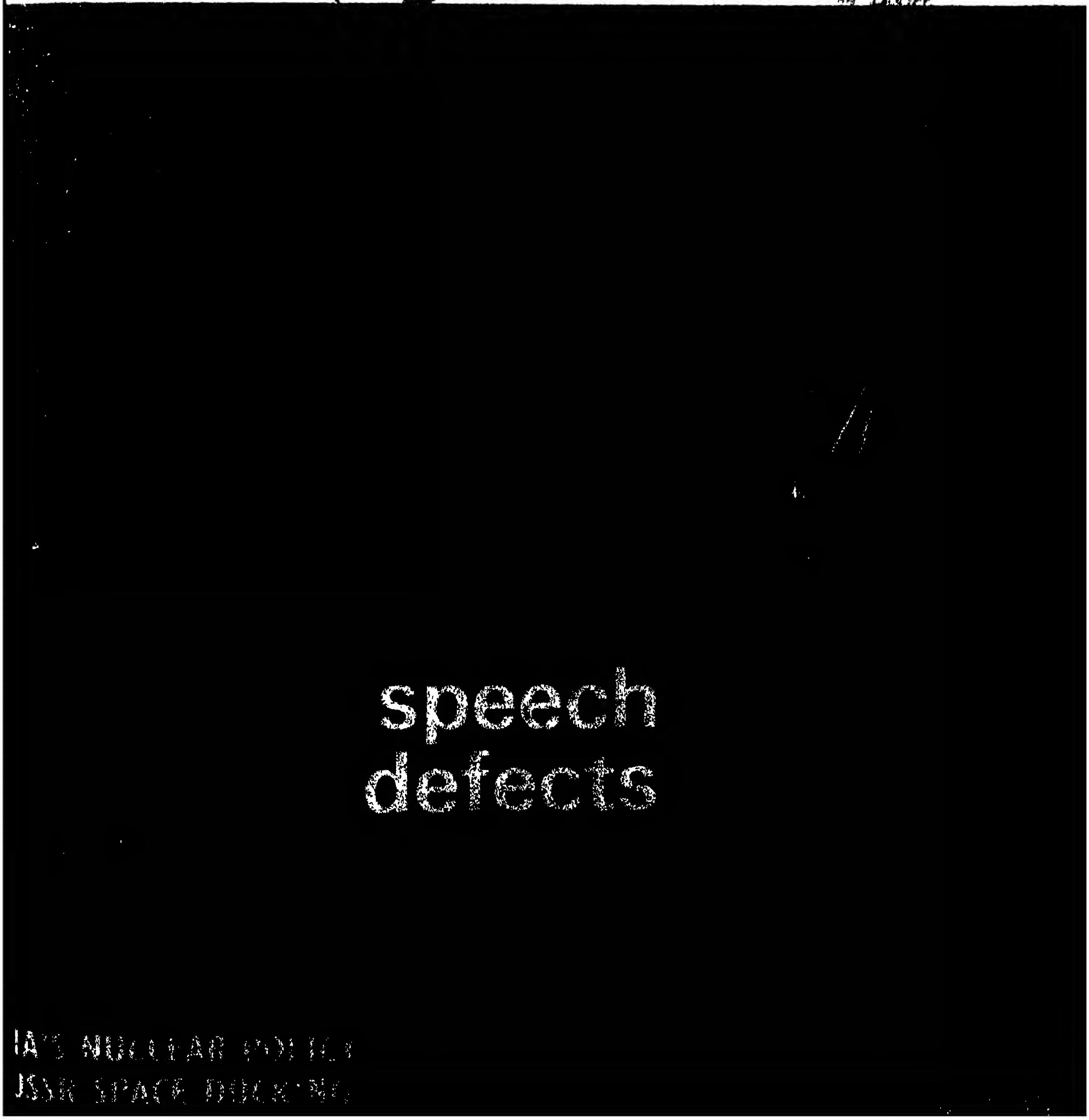


A TIMES OF INDIA PUBLICATION

APRIL 1972

SCIENCE TODAY

FOR EVERYMAN




FOR CLOSER, SAFER SHAVES
Godrej
lather shaving cream
Godrej Shaving Cream with anti-infection Hexachlorophene

Vol. 6 No. 10 April 1972

SCIENCE TODAY

ARTICLES

FEATURES

(Cover designed by Shabbir Diwan)

Annual Subscription Rs. 12·50

Single copy: Rs. 1·25; 10p

Editor

Printed and published for the proprietors Bennett, Coleman & Co., Ltd., by Pyarelal Sah at the Times of India Press, Bombay, India. Delhi Office: 7, Bahadur Shah Zaffar Marg, New Delhi 1.

ABOUT THE AUTHORS

ASHOK KAPUR (*India's Nuclear Policy*) is Professor of International Affairs at the University of Waterloo, Ontario, Canada. Prof. Kapur writes on defence and foreign policy for special and military journals in the US, England and India. This article is part of a larger study, and was written while the author was preparing to give a talk at the Pentagon.

K. N. JOHRY (*Superconductivity*) is Principal Scientific Officer in the Department of Science and Technology, Government of India. Earlier, for several years he was with the Council of Scientific and Industrial Research and Science Attache at the Indian High Commission in England.

RAMESH K. OZA (*Speech Defects*) is Professor and Head of the Audiology and Speech Therapy School, T. N. Medical College, Bombay.

Prof. Oza specialised in speech pathology and audiology from Brooklyn College, City University of New York, USA. He is an adviser on speech and hearing programmes to several hospitals and universities.

PRAVIN KUMAR (*The Scientific Art of Spying*) is Chief Sub-editor of SCIENCE TODAY.

LETTERS

I INTEND to publish a review of hypnosis in India. There is a renewed interest in the clinical use of hypnosis in the UK, Canada, West Germany and other European countries and also in Russia and Japan. Hypnosis has been found useful in the treatment of many psychosomatic disorders. Hypno-anaesthesia has been used for painless childbirth and in dentistry.

Though there are some scientists in India working on experimental or clinical hypnosis, very little is published from their work. I, therefore, request psychiatrists, psychologists and physicians using hypnosis or familiar with works or reports on the use of hypnotism in India or anyone having factual information on this subject to help me by sending data, published or otherwise, to me. I would also like to know about the experiments being done so that they may be included in the review.

Dr. H. Jana
Professor of Physiology
N. H. L. Municipal Medical College
Ahmedabad-6

AWARDS & APPOINTMENTS

Bhatnagar Awards

TEN scientists and technologists have won the Shanti Swarup Bhatnagar Memorial Awards for 1968 and 1969. The awards, given by the Council of Scientific & Industrial Research, New Delhi, were announced in early March. The awards are for outstanding contributions in physical, chemical, biological and medical sciences, engineering and mathematics. Each award carries a cash prize of Rs. 10,000.

The award winners are:

Physical sciences: Dr. A. P. Mitra, scientist, National Physical Laboratory, New Delhi (1968), and Dr. A. N. Mitra, Delhi University (1969).

Chemical sciences: Prof. C. N. R. Rao, Head of the Department of Chemistry, Indian Institute of Technology, Kanpur (1968), and Prof. A. C. Jain, Head of the Department of Chemistry, University of Jammu (1969).

Biological sciences: Dr. T. A. Venkatasubramanian, Head of the Biochemistry Department, V. P. Chest Institute of Delhi University (1968).

Engineering sciences: Dr. K. R. Chakravorty, Director, Fertiliser Corporation of India, P. and D. Division, Sindri (1968).

Medical sciences: Dr. Uttamchand K. Sheth, Head of the Department of Pharmacology, S. G. S. Medical College, Bombay, and Dr. S. R. Mukherjee, Professor-in-Charge, Department of Experimental Medical Sciences, Institute of Post-Graduate Medical Education and Research, Calcutta (joint award for 1968). Prof. L. Kalyanaraman, Professor of Neurosurgery, Madras Medical College, and Prof. Ranjit Roy Chaudhury, Director, Post-Graduate Institute of Medical Education and Research, Chandigarh (joint award for 1969).

The awards were instituted in 1957 to commemorate Dr. Shanti Swarup Bhatnagar, an eminent Indian scientist. So far, 47 scientists have received the awards.

IN THE FORTHCOMING ISSUES....

BURNS AND FIRE HAZARDS

SOUNDS IN THE SEA

ATOMIC CLOCKS

SCIENCE SHAPES LIFE

THE SWEET NATURAL SWEET

"Monellin" is a sweet sweet. And it is a natural sweetener 3,000 times sweeter than an equal weight of sugar. Drs. James A. Morris and Robert H. Cagan of Monel Chemical Senses Center, University of Pennsylvania, USA, isolated this sweetener of soluble protein from West African wild red berries (*Dioscoreophyllum cumminsii*). Monellin is the first reported protein to elicit a sweet taste in man and is the sweetest natural product known. Further studies on its composition, structure and properties are being conducted though only 50 mg of it is available.

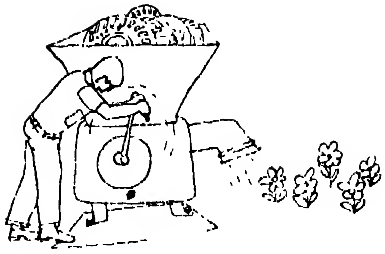
WALKING GUN

The war machine has acquired a new component -- the walking howitzer. This 105 mm howitzer which can be driven conventionally over hard ground can also "walk" through swamps, deep mud and similar difficult terrain. It is powered by a conventional engine with hydrostatic drives.

HORMONES AND LUNG CANCER

The debates have been interminable. Yet people are not sure for a fact that smoking does cause lung cancer. And while the debates rage, a Scottish scientist has come out with a new correlation -- between lung cancer and low levels of the steroid hormone, androsterone. L. G. S. Rao of the Southern General Hospital, Glasgow, asserts that "the association of lung cancer with cigarette smoking is far less significant than that with steroid abnormalities".

Rao says the link is so strong that lung cancer can be diagnosed if there is an androsterone deficiency. And androsterone therapy might prove an efficient weapon in combating this cancer. But Rao is not sure of many things: Is a low androsterone level a cause, an effect or a mere marker of lung cancer? Moreover, low hormone levels do not result from the presence of a lung tumour. Nor are they related to the stage of the disease. What androsterone levels are related to is the bodily resistance to tumour growth.



DON'T THROW AWAY THOSE OLD TYRES

No don't. Just grind up your discarded automobile tyres, mix them with top soil at concentrations of 5 to 10 per cent and you will have plants emerging from the soil "significantly faster". So say Drs. Rollin C. Glenn and C. Y. Ward of Mississippi State University, USA. Rubber particles, they say, improve soil cohesiveness and water penetration and retention and prevent soil from crusting. Such rubberised manure could be of aid in intensive-use areas like playing fields but might not be as beneficial in other areas for the zinc oxide added to rubber to facilitate vulcanisation can prove toxic to plants.

NERVOUS PLANTS

Touch the sensitive *mimosa pudica* and its leaves gently collapse. Or get into the clutches of a venus fly trap and it snaps shut. People have used these examples as evidence that plants too transmit messages through nerves. And now, Barbara Pickard of Washington University, USA, has presented further evidence of spontaneous voltage fluctuations in plants.

Pickard started on the assumption that the electrical fluctuations in the mimosa and fly trap are amplifications of normal properties of all plants. She examined morning glory and cocklebur. Sure enough she found spontaneous but regular voltage fluctuations resembling action potentials. The potentials which occurred at intervals of one to 10 seconds

lasted between 100 and 400 milliseconds.

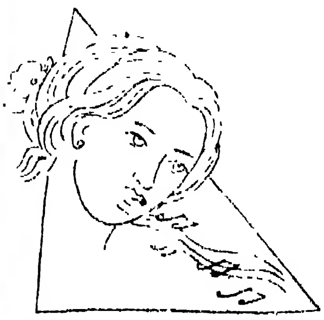
This discovery is important for it might explain many of the floral mysteries that still linger. Such impulses might in all probability release chemicals at distant parts of a plant to induce flowering and other activities — in fact there is a theory, as yet unproved, that links a hypothetical chemical, florigen, to flowering. And the impulses may also cause the release of ethylene that helps pea tendrils to curl. Or action potentials might merely be part of a large complex physiological system.

THE TELEVISION APES

They like westerns — the chimpanzees; the more action the better. Gorillas and orang-utans prefer soap operas—they shy away from violence. Well, if people can do it so can they. Dr. Geoffrey Bourne, director of the Yerkes Primate Research Center at Emory University in Georgia, USA, installed 15 TV sets in the primate quarters. The apes got involved in TV, watching as intently as humans and feeling more relaxed in the process. In fact, some sat spellbound through a two-hour movie though others kept changing channels constantly.

BIRTH CONTROL — THE SOUND WAY

If your wife sings you can tell if she's in her menstrual cycle or not. V. T. Wynn of Exeter University studied absolute pitch, the ability to identify a note without the aid of a reference note. He studied two women musicians, one his wife, and found that pitch recognition varied slightly in the menstrual cycle. While singing the note A (440 Hz) over their cycle, the pitch dropped by about 4 Hz during the first half of the cycle but picked up again after the fourteenth day. This was the time of ovulation. The note kept rising till two days before the next cycle. In itself pitch recognition can thus serve as a guide to fertility and may prove the ideal birth control method for the more musical minded. And, of course, the next time you hear a cat caterwauling or a dog baying, you can tell they are out serenading, giving their prospective mates precise information on their fertility.



ASPIRIN FOR BIRTH CONTROL ?

They called them the new wonder drugs — the prostaglandins. These prostaglandins, a class of natural body chemicals, are believed to be secondary hormone messengers in a number of biological functions. And two of them are known to induce abortion in women in labour. Further, aspirin and the arthritis drug, indomethacin, inhibit yet another prostaglandin. And now Harold R. Behrman and Gayle P. Orcyzk, two Harvard physiologists, have successfully used aspirin and indomethacin to inhibit ovulation in pregnant rats.

No one knows exactly how prostaglandins have so many biological functions and how they act at the tissue and cellular levels. But there are explanations for the suppression of prostaglandins by these two drugs. The first is that these drugs block prostaglandin synthesis in the ovary. The second is that they turn off luteinising hormone which is regulated by prostaglandins.

Women on high doses of aspirin have a difficult time getting

pregnant. Yet aspirin can as yet not be a successful birth control drug for even a daily dose of 8 to 16 aspirin could produce adverse toxic effects.

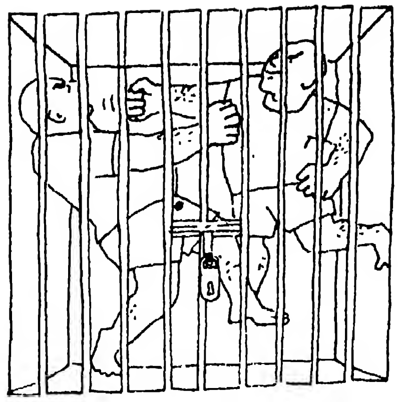
AGGRESSION : LEARNED OR INHERITED ?

An interesting question — is aggression learned or inherited? And, of course, two factions to support both views. Anthropologist Louis B. Leakey says intra-species aggression was foreign to man's primate ancestors. They became aggressive just 40,000 years back when they began living together in groups. But then there is the view of Harry F. Harlow of the Regional Primate Center at the University of Wisconsin, USA. He and Allyn C. Deets of the University of Pittsburgh Laboratory of Clinical Science feel that "aggression most likely remains in man as a solid component of his biological heritage as a primate".

Their statement is based on the experiments they carried out. Monkeys, isolated from birth, were threatened by the experimenters. That, of course, made them show a marked hostility to humans. But when humans were not around they eventually turned their hostility on themselves, by biting their own bodies and throwing themselves against their cages. The monkeys, say the researchers, were never taught to be aggressive; they inherited the trait.

AND MORE AGGRESSION

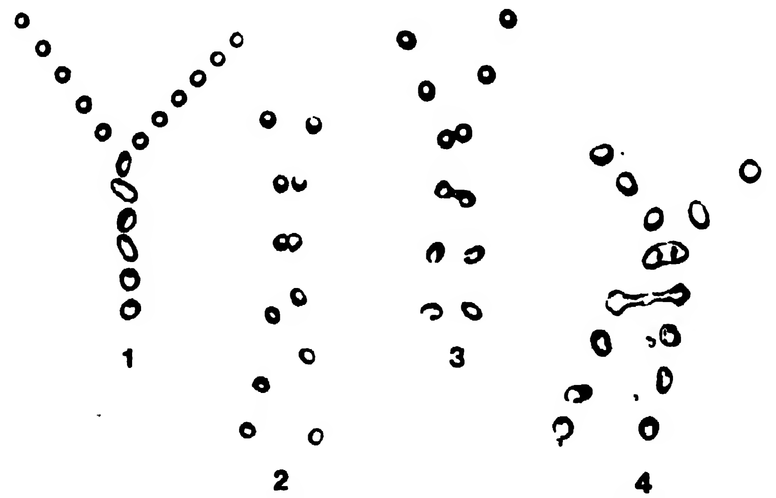
Another group at the Regional Primate Center studied the conditions that caused increased aggression. They placed four monkeys in a cage intended for a single monkey. The animals showed signs of unusual stress and they became alarmingly aggressive. So much so that one group of monkeys had to be replaced when it became evident that one of the four was about to be killed by its cage mates.

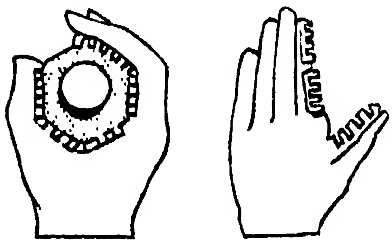


On the other hand, four monkeys placed in a larger cage showed less aggression to their fellow primates. Even if aggression occurred, each had a better chance of escape. Which all goes to show that it is highly impractical to strive to reform prisoners to a normal, well-adjusted life outside prison if they are kept in crowded cells.

THE CASE OF THE COLLIDING RAINDROPS

Look at the pictures here. Not doodles but remarkable photographs (printed graphically) of several types of interaction between colliding droplets of water. P. R. Brazier-Smith, S. G. Jennings and J. Latham of the Manchester University Institute of Science and Technology conducted an experiment with drops, 150 to 750 micrometres in diameter, ejected from a pair of hypodermic needles. They investigated the separation of droplets after coalescence. The velocity of the drops were between 0·3 and 3·0 metres per second — the velocity range of drops in rain clouds. The first photograph shows permanent coalescence, a common enough occurrence. Straightforward bouncing at low speeds is illustrated in the second photograph. The third shows a partial coalescence followed by a separation and the last one shows colliding drops with large angular momentum that draw out liquid filaments which break into smaller drops. The investigators intend studying the influence of these droplets on precipitation.





A SIMPLE WRENCH

What would you do if you have to open a plumbing drain under a sink or fit a nut inside a tank? An ordinary wrench will be difficult to handle in such cases. An American inventor has developed a wrench which is attached to the hand glove. The glove has ribbed plastic inserts attached to the thumb and the forefinger. It can be easily held around the nut and worked.

THE "HOW TO SPOT A HIJACKER" GAME

In February this year, a man claiming to be deaf and dumb was stopped from boarding a plane in the US. His behaviour was odd. But then he produced a commercial pilot's licence and it was a genuine licence. So there he was on the plane and sure enough he hijacked it. Whoever heard of a deaf and dumb pilot? That just goes to show how difficult it is to spot a potential hijacker. But methods have been worked out and methods are being bettered and streamlined. Like the mechanical gadgets. They have X-ray eyes which can see through a bag, magnetometer detectors that can detect metallic objects through fluctuations in magnetic field, all-metals electric coil detectors, bomb sniffers that smell vapours from some explosive chemicals, and of course, nightstick-type detectrons (See Science Today, March 1971, p. 12).

But there is yet another factor. And an important one at that -- the hijacker. What type of person is a potential hijacker. How does he behave? What does he want? What does he seek to prove? What are his reasons for hijacking? And, of course, how does one spot a potential hijacker? Some of the answers are provided in the report of an American psychiatrist, David Hubbard of Dallas, Texas, which was made available recently. Here's how it goes:

Our man is likely to be shy and extremely soft-spoken, probably small, unathletic, clumsy and with poor coordination. He is definitely not the sporty type — he feels "trapped" by sports. His incoordination manifests itself in little things — he might not be able to reverse his car, he cannot tie his shoe laces, he cannot judge distances. . . .

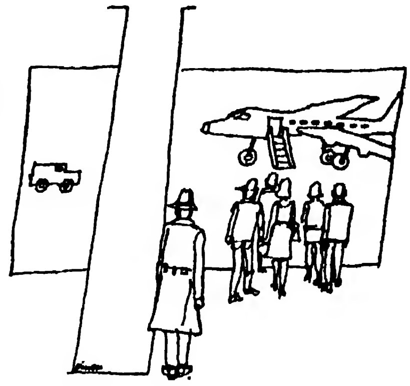
He comes well-equipped in a sense. Briefcase with stickers from previous flights, an air of knowing his way around, the attitude of a regular flyer. But in other ways he is ill-equipped. He might sport light summer wear when his flight is scheduled for a wintry clime — betraying his purpose of hijacking the plane to a sunny land, in most cases Cuba. He carries insufficient luggage for the trip he plans — often a mere suitcase, and a half-empty suitcase to boot.

There is another giveaway sign. Though a seasoned traveller he is ubiquitous — or rather not ubiquitous but enquiring. What are the stops en route? How many passengers does the plane carry? What is its cruising height? Where are the engines located? How far are places not on the route? When does the plane leave? Typical questions all.

The hijacker is not so much the mentally unstable person he is thought to be. Most unstable people wish to avoid everyone else. So they choose the large reception halls and loiter in big open spaces — they feel anonymous and free. But our man feels trapped. He clings to walls and pillars, uses circuitous routes to go from place to place in the terminal, goes to shops without buying anything, steps into telephone booths and lavatories without using them.

He is normally an experienced traveller or rather an active traveller. Many of his kind find an enjoyment in travel - a way to cope with stresses and crises. One of them used part of his Rs. 25,55,000 legacy for a two-year travel hitch of 320,000 kilometres before becoming hijacker. Another jumped aboard a New Orleans-Houston-Los Angeles-Colorado round trip flight everytime he sensed a family spat in the offing. He finally took more than a round trip — going all the way to Cuba.

Mr. Hijacker uses his own money for his peregrinations. Among the many hijackers he interviewed in private, Hubbard found only three to be unemployed at the time of their abortive attempts. Unemployment might have led to the attempts but the more probable reason is usually suicide. In style too. For they



normally carry unloaded guns and go to the great beyond a la cops and robbers style — with a bullet in their gizzard from a cop gun. It is not a joke. Psychiatrists have come to the conclusion that American bank robbers confront the police with suicide on their mind and the hope of a parcel of lead. So is the case with hijackers.

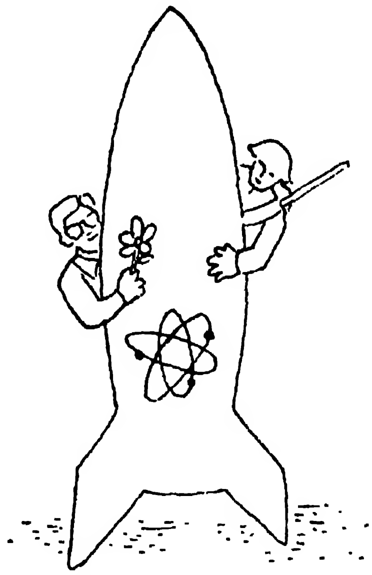
Why the rash of hijackings in the world, especially in the US? (it accounts for 31 per cent of total hijackings). Hubbard holds manned spaceflights culpable. When there was no dearth of manned spaceflights there was a corresponding lack of dearth in hijacking attempts. Coming back to our man — he feels he will be free in space — in the vast emptiness — free, weightless and unattached. Yet now that spaceflights have moved off the limelight, hijackings don't seem to stop. Here again, the art of hijacking has become important in its own right, moving along steadily on its own momentum.

But there is one area Hubbard has not touched — the politically conscious hijacker who attempts these bravura acts for political reasons. Hubbard hasn't been permitted to interview them. But they too probably row the same psychological boat.

And so, even as a system of spotting hijackers through behaviour patterns is emerging, the hijackings continue apace. Why just the other day a Lufthansa plane was hijacked while on a trip from Delhi. But the story might just have a happy ending, might just. . . .

PEACE? OR SECURITY? SOME THOUGHTS ON

India's nuclear policy



ASHOK KAPUR

WHEN India entered the atomic club in the mid-1950s Jawaharlal Nehru declared that he proposed to use atomic power for peaceful purposes only. A similar declaration of intention has been voiced by Nehru's successors. During the nuclear non-proliferation treaty negotiations, the intention to adhere to a "peaceful uses only" stance was reiterated by Indian negotiators in Geneva and New York although the nuclear treaty had been rejected by India. These declarations are not convincing because this is a policy declaration rather than a legal commitment of the Indian Government. The policy declaration can change, just as the attitudes within the government can change over a period of time as India's nuclear-oriented projects become operational. The declaration that India will continue to use nuclear energy for peaceful purposes does not really say very much because the meaning of the term "peaceful uses" is not clear and in fact has never been clear in disarmament debates in Vienna, Geneva and New York. Furthermore, the peaceful uses declaration clouds the nuances involved in the shifts in India's nuclear policy during the 1954-70 period.

The tension between "peace" and "security" was inherent (but not explicit) in the nuclear debate in government circles in India during the early 1960s — a time when India's commitment to peaceful uses of nuclear energy appeared to be a firm one. Even though India's rhetorics about peaceful uses of nuclear energy have remained unchanged since the 1950s, the point can be made that the security content of India's nuclear policy has taken concrete shape over the years, while the peace content has declined.

In general, the growth of the security content was related to two significant trends in world politics: first, the declining prospects of meaningful nuclear disarmament, and continuation of the strategic arms race between USA, USSR and China meant that the arms race could be modified but it could not be eliminated; secondly, the proposition was developed by Indian experts that since India could not reverse this trend, it was necessary for India to participate in the advanced technological systems, otherwise it could find itself outside the technological and industrial modernisation processes. Thus, according to these experts, in so far as the organisation and distribution of world power depended in part upon advancement in the industrial and technological sectors, India could not afford to ignore advances in the space and nuclear-oriented projects if it wished to retain its claim as a major power.

Specifically, the growth of the security content in India's nuclear policy can be identified in four important policy areas in Indian foreign policy. The first dealt with the policy debate within the Indian Government which started with policy exchanges between Jawaharlal

Nehru and Homi J. Bhabha. These interactions between the Prime Minister's Office and the Atomic Energy Commission continued after Nehru's death, and as security issues (such as the 1962 conflict with China, the 1965 war with Pakistan and the 1965-68 international nuclear debate) became prominent in Indian foreign policy, opinions about India's nuclear options also became intense.

The second important policy area concerned the cooperation between India and Canada and USA in the nuclear field. The principles of cooperation between India and Canada, the distrust in USA and Great Britain about India's nuclear intentions, and the stringent conditions of American nuclear aid to India, are the three main nuances in this policy area. Thirdly, India's position in the discussions at the International Atomic Energy Agency in Vienna and at the Disarmament Conference at Geneva reflected the link between commercial, technological and political objections in India's nuclear policy. Finally, the last policy area concerns the attitude of the USSR toward an Indian nuclear programme of a military nature. This policy area is not yet contentious in Indo-Soviet relations but now that the Indo-Soviet military and political alignment has been put on a firmer and a formal basis, the contours of Soviet attitudes are likely to grow from an assessment of Soviet strategic interests in their regional and global aspects.

Policy debate in the Indian Government

The foundation of India's nuclear programme and policy was laid in 1944 with the establishment of the Tata Institute of Fundamental Research; this Institute was established under the guidance of Homi Bhabha.

Although the Indian programme was conceived through the 'atoms for peace' concept, Bhabha's commitment to the peaceful uses of nuclear energy was restricted to a point, and he never lost sight of the potential military uses of atomic energy. From the beginning, India's atomic energy development programme was more broadbased than that of China, and although there was no specific coupling between the peaceful and military uses of nuclear energy, the vast potential of the Indian programme as originally conceived provided a built-in scope for a military programme. While documentation on this point is still secret, it is reasonable to infer from the interviews which this author conducted in New Delhi, Ottawa, New York, London and Vienna,

Dr. Bhabha did not have a rigid attitude with respect to the use of nuclear energy for military and political purposes.... Because of his realpolitik approach, Bhabha did not show much enthusiasm for disarmament. After Nehru's death, Bhabha reacted immediately to the Indian NPT memorandum

that Nehru accepted Bhabha's concern about the military uses of nuclear energy. Furthermore, support for this proposition can be found in the Indo-Canadian negotiations concerning the first phase of the Rana Pratap Sagar project (RAPP); during these negotiations, India rejected Canada's proposal for a rigid safeguards system. All in all, it is fair to state that in the late 1950s and the early 1960s, the military uses of nuclear energy had not been ruled out by the Indian Government. The nature and scope of the safeguards system of the International Atomic Energy Agency had not been finalised while negotiations for RAPP I were underway, and Dr. Bhabha was able to drive a hard bargain with Canada. The principle of bilateral and reciprocal safeguards between RAPP and the Douglas Point reactor in Ontario (Canada) was adopted by Canada and India. From India's point of view the agreement was important because it contained the principle of reciprocity and it extended only to first generation fissile material. In addition, Bhabha signed a technical assistance agreement whereby he purchased the design and the know-how of Canada's CANDU reactor, with the right to copyright to future design. This agreement was obtained under the Colombo Plan for Rs. 37·5 million.

Perspective of attitudes

Two perspectives should be kept in mind in outlining the nuclear debate within the Indian Government : first, the intellectual and policy commitments of Dr. Bhabha and his successor Dr. Vikram Sarabhai seemed to differ in that Dr. Sarabhai had a preference for the Pugwash approach to control of nuclear energy and this preference seems to have conditioned him about the dangers of using nuclear energy for military purposes. (In fairness, however, to the late Dr. Sarabhai it should be added that his attitude on this question seems to have changed during the course of the nuclear debate in

Dr. Sarabhai had a preference for the Pugwash approach to control of nuclear energy.... [It] seems to have conditioned him about the dangers of using nuclear energy for military purposes.... However, his attitude seems to have changed during the course of the nuclear debate in 1965-68-71

1965-68-71). Dr. Bhabha on the other hand did not have a rigid attitude with respect to the use of nuclear energy for military and political purposes. The second perspective lies in the evolution of the attitudes of Indian Prime Ministers towards the security aspect of nuclear energy. The general proposition can be advanced that the manner in which Indian Prime Ministers perceived the security role of nuclear energy depended upon the importance they attached to the security question in India's foreign policy.

Two instances show how the intellectual commitments and the policy perceptions of Dr. Bhabha and Dr. Sarabhai produced shifts in India's nuclear policy. The first instance concerned the differences in the outcome of negotiations between RAPP I which was negotiated by Bhabha, and RAPP II which was negotiated by Sarabhai because Bhabha died while the latter negotiations were still in progress. The basic difference between RAPP I and RAPP II is that the first is under bilateral safeguards while the second is under trilateral safeguards involving the International Atomic Energy Agency. The differences in the commitments and perceptions between Bhabha and Sarabhai seem to have influenced the Canadian and French attitudes. In 1966 (when Bhabha died), France was prepared to help India's nuclear programme without insisting on safeguards, but the French lost interest after Bhabha's death. Similarly, the differences between the two Indian scientists seem to have produced a difference in Canada's negotiating behaviour towards India. During RAPP I, Canada's position toward India was basically defensive, but during RAPP II, the Canadian demands increased. The nature of the Canadian demands are reflected in the Trilateral Agreement between India, Canada and the International Atomic Agency signed in 1971.

The second instance concerned the attitude of the Indian Atomic Energy Commission on the signing of the nuclear non-proliferation treaty. Because of his realpolitik approach to nuclear issues, Bhabha did not show much enthusiasm for disarmament. This is evident from the fact that after India tabled the NPT memorandum after Nehru's death, Bhabha reacted immediately to the Indian move. Because the Indian policy-making mechanism depends upon personal ties and because there was little rapport between Bhabha and Prime Minister Shastri, there was little or no coordination between Bhabha's Atomic Energy Department and the Ministry of External Affairs. Fortunately, veteran Ambassador V. C. Trivedi, in his forceful interventions in the Geneva disarmament debate recognised the diplomatic and security aspects of nuclear policy and the implication of China acquiring the Security Council seat. Both these aspects had been emphasised by Bhabha.

If the intellectual commitments of Bhabha and Sarabhai influenced the policy recommendations of the Atomic Energy Commission, the perceptions by Indian Prime Ministers of the international environment as it applied to South Asia influenced the value which the leadership attached to nuclear energy in Indian foreign policy. Again, two instances are noteworthy. During Nehru's tenure, the military aspect of India's nuclear policy was implicit in the Indian programme and it was probably on the basis of this implicit policy that Dr. Bhabha declared that he could produce the bomb within eighteen months. After Nehru's death, Bhabha had little or no rapport with the Prime Minister's Office. However, after the 1965 conflict with Pakistan, Lal Bahadur Shastri began to appreciate Bhabha's view that it was necessary to enhance the security role of India's nuclear energy programme. The establishment of the Electronics Committee after the 1965 war and the reduction of the time-lag for a detonation from 18 months to about 3 months revealed a new orientation toward ' power ' in India's nuclear plans.

India and the West in nuclear energy

India's relationship with the West began with discussions about the principles of co-operation between India and Canada. During 1954-58, there were certain decisions in principle and the decisions were taken within the general framework of an interesting and intimate personal relationship between Nehru and the Canadian Prime Minister St. Laurent. The relationship was interesting because the friend-

ship between the two blossomed and led to an interest in finding bilateral methods for solving problems which often had a multilateral angle. The questions of disarmament and the overall pattern of political relationships in South Asia were the type of issues where the bilateral approach appealed to the Indian and the Canadian Prime Ministers. Because countries like India and Canada were trying to depolarise the hostility between Washington and Moscow, the bilateral method became a cornerstone in Canadian and Indian approaches to foreign policy.

In addition to this general identity in approach, Canada adopted the view that nothing should be done to disturb the Indian sub-continent. Generally, therefore, Canada was receptive to types of exchanges with India that could over the years strengthen the Indian economy. Also at the time when the principles of Indo-Canadian cooperation were under negotiation, Britain was launching itself into a peaceful purposes nuclear energy programme of some consequence. This was taking place in a Commonwealth setting, and the structuring of Canadian atomic aid to India under the Colombo Plan umbrella could have been a response to the Colombo Plan mystique. Finally, at the lower echelon of the Canadian bureaucracy, there was tremendous respect for Homi J. Bhabha as a scientist. Although this is unlikely to be the reason why Canada chose to share its atomic technology with India, the personal relationships undoubtedly facilitated inter-governmental cooperation. There were some objections from Britain and USA. Having lost its empire in India the British wanted to make sure that the Indo-Canadian atomic arrangements would lead to peaceful uses only ; the American President held a similar position. But the Canadian and the Indian Prime Ministers had confidence in each other and believed that the letter and spirit of the agreement would be respected by the two governments.

Indian, Soviet and American strategic bargaining on nuclear policy

In the light of the foregoing it is clear that India sought to advance its nuclear technology by cooperating with the Western nations. This cooperation has been marked by hard bargaining and strains in bilateral relations because India has refused to accept discriminatory policies advanced by the United States in the International Atomic Energy Agency and subsequently in the Geneva Disarmament Conference. Oddly enough India did not seek atomic energy assistance from the Soviet bloc although there is the precedence of a USSR agreement with Pakistan to establish the nuclear project at Roopaur in East Pakistan. While there is a history of Indo-British jealousies about the nuclear programmes of these countries, and while the Americans have had a persisting suspicion of a nuclear India which would have the power to challenge American leadership proposals in international security affairs, Moscow has been somewhat reluctant to openly oppose India in the nuclear energy field. This was so largely because India's leadership and expertise in disarmament affairs did not impinge upon Soviet interests, and secondly, because Indian disarmament role was functional in terms of Soviet disarmament policy. Even during the nuclear non-proliferation treaty debate, Moscow conducted itself in a low key manner with respect to India.

One explanation of Moscow's relative disinterest in India during the NPT debate is that West Germany rather than India was Moscow's real target. But if India (irrespective of the existence of the Indo-Soviet Friendship Treaty) is unlikely to be a nuclear threat to Moscow in a purely military sense, there is one important scenario in which India's nuclear policy should be a matter of great concern to Soviet strategists, that is, if India's nuclear behaviour does not conform to the Soviet concept of collective security in Asia.

It is evident from the Indo-Soviet treaty that India has been elevated in Soviet diplomacy in the sense that India is being formally treated as a vital political flank in Soviet policy toward China. For this Moscow has had to pay a price. In addition to the military aid which India receives (for which India pays but which is not readily available from alternative sources), the diplomatic payoff from Moscow to Delhi comes in the form of the undertaking by the USSR that irrespective of who fires the first shot in an India-China confrontation, the USSR will not help China against India. The reciprocal payoff from Delhi to Moscow comes in the following forms : (*i*) that India will continue to be hostile to China; (*ii*) it will continue to have a modern conventional military deterrent against China ; (*iii*) and it will utilise its increased freedom of action to challenge Peking's positions in Asia.

Logically from the Soviet perspective the scenario should end at this point. In other words, from the Soviet point of view a hard and

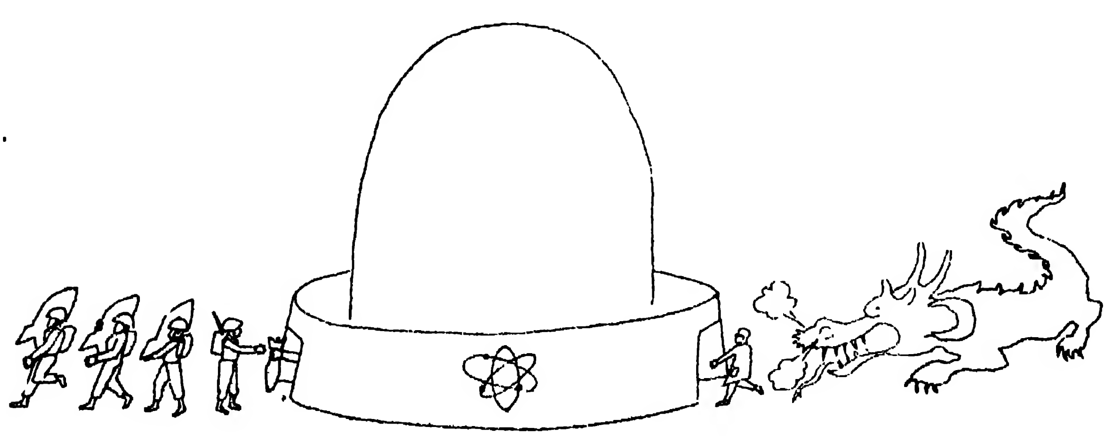
fast line must be drawn between a modern conventional Indian military deterrent which functions within the framework of the Indo-Soviet Treaty, as contrasted with a combined Indian conventional and nuclear deterrent. From the Soviet perspective there are two objections to the latter combination. First, a conventional-nuclear Indian deterrent would make India ' too big ' for the Soviet Union in a political sense. A nuclear India would obviously have its own voice in international security debates and with such an independent voice its receptivity to Soviet views may decline. Secondly — and this factor has greater international significance — when India goes nuclear, Japan is likely to adopt the nuclear path also. And who knows when the right-wing gentlemen with hot lines to *Der Spiegel* will want a nuclear Germany ? Thus, whether or not West Germany goes nuclear, the prospect of nuclear programmes in India and Japan will pose insurmountable political difficulties for the Soviet (and Chinese) strategists in their plans to shape the post-Vietnam political order in Asia.

Shift in India's nuclear policy

From the foregoing one can see that India's nuclear policy has passed through several stages. As a general observation it is fair to assert that the policy of maximum self-reliance induced India to seek nuclear aid from Canada and to a lesser extent from the USA because the aid terms of the latter were far too rigid for India's liking. Nevertheless American aid was secured for a dual purpose : first, it gave valuable experience to Indian scientists in enriched uranium technology, in addition to the experience in natural uranium which India derived from Canadian technology. Secondly, American nuclear assistance created the precedent of US aid in a sensitive technological area. While the history of US safeguards philosophy shows that the US policy is to create technological barriers for the near-nuclear weapons states, at the same time it is obvious that the Americans are a realistic people. If it appears that India is close to beating the technological barriers, then it is conceivable that the US may even agree to share its enrichment technology with India.

What then, are the possibilities ? Unless Prime Minister Indira Gandhi loses her predominant position in Indian politics, the shift in India's nuclear policy seems to be inherent in two factors : first, the nuclear treaty proved that in the view of the superpowers the world was to be divided into the nuclear haves and the have-nots, with the implication that the nuclear haves would have the ' responsibility ' for shaping international security debates and thereby asking the right questions. India opposed this view, but until it goes nuclear its opposition is merely verbal and rhetorical and the substance of NPT will have been implemented in practice if not in theory.

Secondly, after the wars with Pakistan and China, and after India's recent experience in Bangla Desh, it is now clear to the Indian leadership that without power there can be no peace and stability. Furthermore, as a consequence of India's military and political victory in the Bangla Desh crisis, India is the dominant power in South Asia today. But to preserve its dominance, and thereby the stability of the region and the stability of its borders, India will need to keep the great powers in Asia off balance. To bargain one must have the power to hurt, and what better method does India have to bargain with the great powers and to advance its limited interests, than to go nuclear ? When India goes nuclear depends on when it is ready in the space and delivery field, but it is unlikely that the politics of nuclear power is something which has escaped Mrs. Gandhi's thinking.



ROUND-UP OF RESEARCH

Haemoglobins

THE properties of two abnormal human haemoglobins, Rainier and Bethesda, lend strong support to Perutz's theory of how normal haemoglobin works. The properties were examined by Dr. A. Hayashi and Dr. G. Stamatoyanno Poulos of the Division of Medical Genetics, University of Washington, Seattle, USA. The details are reported in *Nature New Biology* (*235*, 70; 19 January 1972).

The function of haemoglobin molecules in the blood is to carry oxygen from the lungs to some distant tissues of the body where it is urgently needed and to neutralise the accumulated carbon dioxides. It has been known for several years that haemoglobin is a complex molecule made up of four sub-units, each a protein containing a long chain of linked amino-acids. Each haemoglobin molecule is composed of two pairs of identical sub-units — two alphas and two betas. Linked with each of these four sub-units is a structure responsible for binding oxygen. The conformation of the four long molecular chains has been found by experiment to be significant in determining the environment of the oxygen binding part of the molecule. This model for the structure of haemoglobin is a result of nearly 35 years' work by the Nobel Laureate. Dr. M. F. Perutz of the MRC Laboratory of Molecular Biology, Cambridge, England.

Just over a year ago, Dr. Perutz used the X-ray diffraction technique (*Nature 228*, 726; 21 November 1970) for working out in detail the structure of the haemoglobin molecule in its ordinary and oxygenated form. His study indicated that there is a significant change in the shape of the haemoglobin molecules when they pick up a molecule of oxygen and also eventually when they release it.

According to the British scientist, when one sub-unit of haemoglobin molecule receives an oxygen molecule, its structure is significantly altered. The oxygen is held by an iron atom which actually contracts. This makes it small enough to be itself gripped by the prophyrins (a ring of atoms containing nitrogen). Certain structural changes also take place at the end of the beta sub-unit. In normal haemoglobin, the amino-acid tyrosine is found near the end of the beta chain. Dr. Perutz believes that tyrosine fits into a pocket on the surface of the beta sub-unit. When an oxygen molecule binds to the surface, however, the tyrosine is forced out of its pocket, and the original structure is no longer held rigid. Now, each sub-unit is very sensitive to changes in the structure of the other three sub-units. Because of this, the structures of the other three sub-units are also destabilised and they too take up the oxygen load readily. Thus one haemoglobin molecule picks up a total of four oxygen molecules.

The reverse effect occurs in tissues that demand oxygen. When the oxygen is released the iron atom expands again, the haemoglobin molecule rearranges itself, and is ready to pick up carbon dioxide. The oxygen-free form is then constrained by salt bridges accompanied by the release of hydrogen ions that neutralise the carbon dioxide. The tyrosines are needed again in this vital process for in their absence the salt bridges involving the adjoining proteins are not made.

The abnormal haemoglobins used by Drs. Hayashi and Stamatoyanno Poulos are the only known variants of human haemoglobins with substitutions for the important tyrosine residues at the end of the beta chain. In haemoglobin Bethesda, tyrosine is replaced by histidine, while in haemoglobin Rainier by a cysteine. Apart from this, the gross structure of these haemoglobins is very similar to the normal form.

In their experiments the American scientists measured the oxygen equilibrium curves of haemoglobins Bethesda and Rainier and normal haemoglobin. They found that the oxygen affinity was nearly 30 times higher in Bethesda and Rainier as compared to the normal haemoglobin. Further, the Bohr effect in haemoglobins Bethesda and Rainier was half the normal value. In haemoglobin Bethesda, which (unlike haemoglobin Rainier) possesses a normal complement of sulphydryl (SH) groups, it was found that the chemical reactivity of this group is different from that of normal haemoglobin; they react usually rapidly in the deoxygenated state.

The above observations are readily explained in terms of Perutz's scheme. Because these haemoglobins lack the amino-acid tyrosine, they are always in the structure type that accepts oxygen, and will not release their load readily when a demand is met. This explains the higher oxygen affinity and reduced Bohr effect. Further, the salt bridge in normal deoxyhaemoglobin physically occludes the sulphydryl group in each beta chain and in the absence of tyrosine, the salt bridge is not made. This explains the higher reactivity of the sulphydryl group in the haemoglobin Bethesda.

Earth's Inner Core

IS the inner core of the earth solid or liquid? This has been an object of some discussion recently among seismologists. Drs. B. R. Julian, D. Davies and R. M. Sheppard belonging to Lincoln Laboratory, Massachusetts Institute of Technology, Massachusetts, USA, have examined the seismic records of five earthquakes that occurred between 1967 and 1969 and have come to the conclusion that the inner core is a soft solid. An account of their work is given in *Nature* (*235*, 317; 11 February 1972).

Our information on the structure of the earth's interior owes a great deal to the science of seismology. It is now known that the earth consists of an inner and outer core, a mantle and a crust at the top. A great deal is known about the earth's outer core — it is liquid and has a radius of 3,480 km, half that of the earth. It is now agreed that the outer core is made mostly of molten iron.

The existence of the earth's core came to light from the detection of a shadow zone for seismic waves extending from 100 to 140 degrees from a source of earthquakes. With improved techniques it was, however, found that the shadow zone is not completely dark, but some seismic energy was recorded inside it. It seemed impossible that the energy was diffracted into the shadow zone by the outer core, and it was postulated by Miss I. Lehmann in 1936 that there should exist an inner core with a radius of 1,200 km from the surface of which seismic waves are reflected into the shadow zone. For many years little more could be learnt about the inner core although it was usually supposed to be solid, not liquid, on account of the increase in the speed of certain types of seismic waves at the boundary, and since the material inside it is expected to be solidified by the pressure above. However, if the observed increase in compressional velocity is related to a compositional change or to a new phase of iron with rearranged electronic orbits, then the inner core might be liquid.

An important development in seismology, in the past decade or so has been the observation of the elastic oscillations of the earth as a whole set up by an earthquake, and the use of arrays of seismometers instead of single instruments in the detection of seismic pulses. Using such an array, Drs. Engdahl, Flinn and Romney found extensive evidence (*Nature 228*, 852, November 1970) that the boundary of the inner core is sharp and that the density just inside must be less than 13·5 gm/cc. However, it was believed that conclusive evidence for the solidity of the inner core would come only from observations of body waves of the type PKJKP, SKJKS and SKJKP, phases that travel through the inner core as a shear wave.

Recently, Drs. D. Dziewonski and Gilbert, using the amplitudes of the fundamental modes and overtones of the free elastic oscillations of the earth, were able to show for the first time (*Nature 234*, 465; 24 December 1971) that the inner core must indeed be solid and that the speed of the shear waves should have the relatively low value of 3·2 km per second.

Drs. Julian, Davies and Sheppard have now in the present report made direct observations on seismic waves known as PKJKP that travel through the inner core as a shear wave. In their study, they used records of five large earthquakes taken with the Large Aperture Seismic Array (LASA) for possible PKJKP phases. The earthquakes used took place in the South Sandwich Islands, Fiji Islands, Chile-Bolivia, the Banda Sea and North-East China. The Lincoln team worked out the directions from which the strongest PKJKP signals would be expected on the solid model, and then estimated how long after the occurrence of the earthquakes the signals can arrive at the seismic array. The calculated travel times turned out to be between 30 and 33 minutes, and the seismic records of all five earthquakes revealed PKJKP waves arriving at just about the right time.

The picture that emerges from these experiments is that the inner core is a soft solid, with a radius about 1,200 km, and its density just within the boundary is less than 13·5 gm per cc.

Slime Moulds

SLIME moulds are fungi found growing on wood, on rocks or on grass; there are some 300 distinct species. They have long been both a botanical and zoological curiosity. They have been considered to be atypical organisms by developmental biologists because of their unique life cycle. They start life as a lot of independent free-moving amoeboid cells. At a certain stage in their life cycle they gather themselves into a long worm-like structure surrounded by a sheath of slime. Eventually, the slime falls over, and the organism crawls off in a form variously known as the slug, grex or pseudoplasmodium.

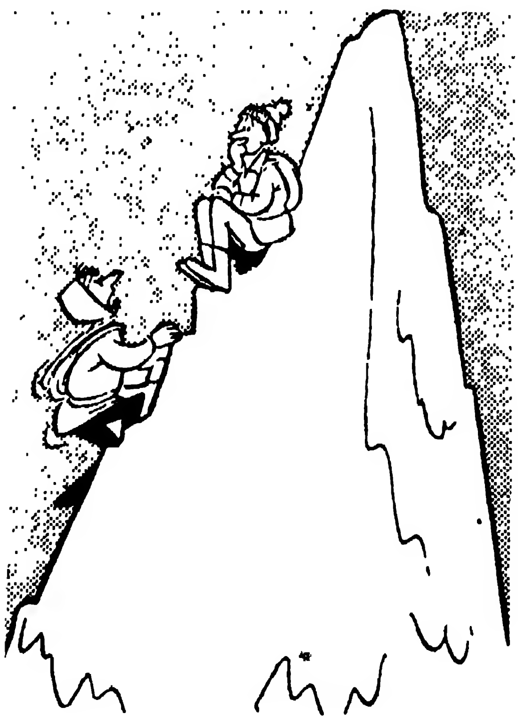
This peculiar developmental behaviour of slime moulds has not been explained so far. Now, a team of biologists Drs. A. D. J. Robertson, D. J. Drage and M. H. Cohen belonging to the University of Chicago, USA, have in an article in *Science* (*175*, 333; 21 January 1972) provided experimental evidence for a theory that the individual amoebae are attracted into the aggregate which forms the slug by periodic signals. These signals consist of chemical pulses of the compound cyclic adenosine monophosphate (AMP) released from the amoebae.

The Chicago scientists studied one particular species of slime mould, known as *Dictyostelium discoideum*. From measurements of other workers, and from time-lapse films of the movements of the amoebae as they streamed into the aggregate, they concluded that each amoeba signals to the next by emitting pulses of cyclic AMP at intervals of five minutes or so, when the aggregation begins. The amoeba which receives the signal, takes one step towards the signal emitting amoeba, pauses for a while, and then releases its own pulse of cyclic AMP. The consequence of the periodic nature of the signals is that the amoebae form streams, which flow inwards to the centre of a growing aggregate in a series of jerks, as the signal is passed from cell to cell. This can be seen in a time-lapse photograph as spreading outwards from the centre.

To verify the theory, the American scientists constructed a device which signalled like an amoeba cyclic AMP, but at a faster rate. This was done on the assumption that the process of aggregation is initiated and paced by the amoeba releasing cyclic AMP at the highest rate. The device consisted of a hollow glass microelectrode filled with a solution of cyclic AMP and held at a voltage that prevented it from coming out at the tip. Every 4½ minutes or so, the voltage was reversed to allow a pulse of cyclic AMP out of the tip of the electrode. When this device was lowered into a glass dish of amoebae, they moved towards it in periodic jerks which were in phase with the periodic release of cyclic AMP from the electrode. The experiment resulted in the production of a fully-formed slug which migrated itself away from the site of the electrode across the glass dish.

Developmental biologists are bound to read with interest the report of the Chicago scientists, since there are periodic phenomena that occur during development like the development of limbs and organs in the embryo which depends on coordinated growth and movement of groups of cells, again believed to be controlled by chemical or possibly electrical signals from cell to cell. There are also tumours in which the cells divide synchronously at regular intervals. It is possible that the type of experimental approach which has enabled the American biologists to imitate the control system for aggregation of *D. discoideum* may provide insight into morphogenesis in general, and perhaps the control of growth in embryos and tumours.

K. A. Neelakantan



"What a moment to decide that fame isn't everything!"

The Long, Long Trip to Jupiter

MAN is now reaching out beyond Mars to take the first close look at Jupiter, the largest planet of the solar system. The long-reaching arm is the unmanned Pioneer F spacecraft, launched by the US National Aeronautics and Space Administration on 1 March, 1972. The trip to Jupiter will last less than two years, with arrival time before 31 December 1973.

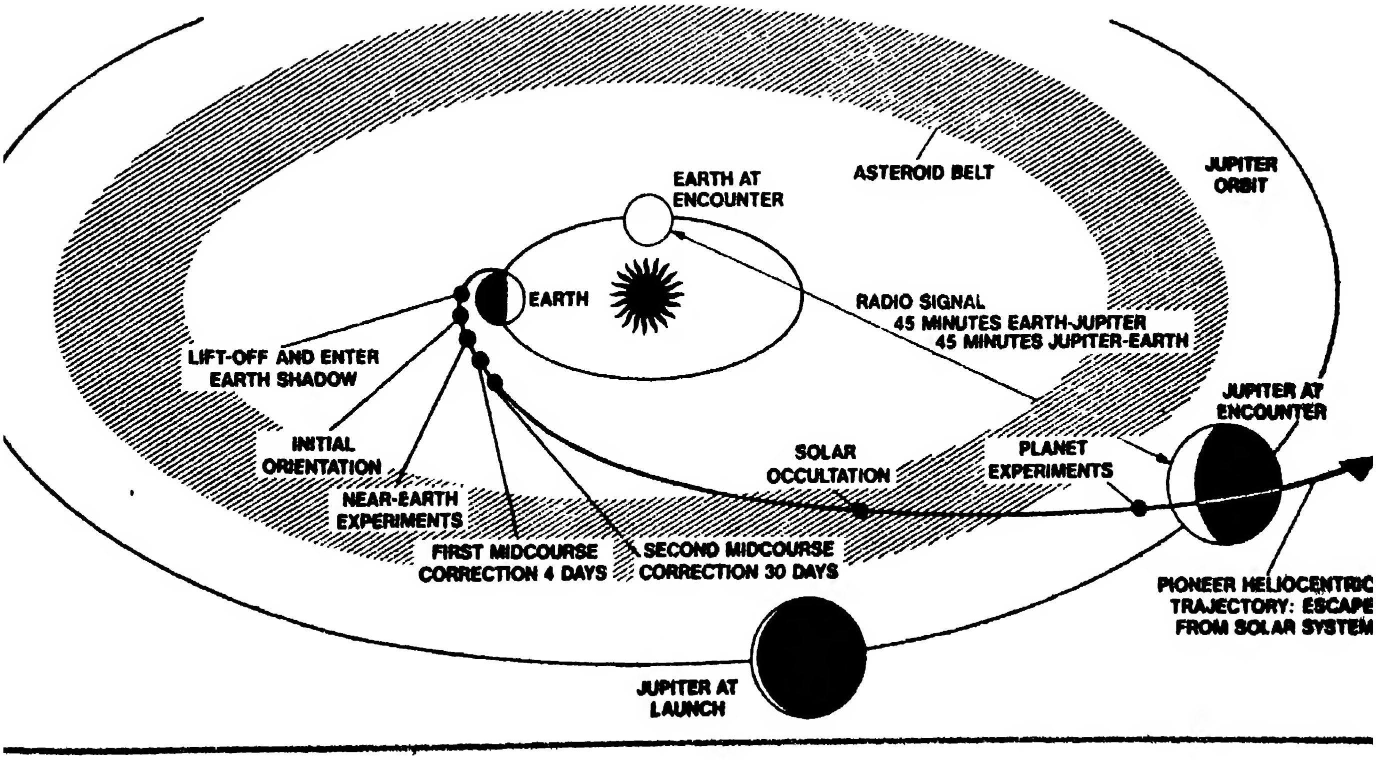
Jupiter is a spectacular planet. It appears to have its own internal energy sources and is so massive that it is almost a small star. It may have the necessary ingredients to produce life. Its volume is 1,000 times that of Earth, and it has more than twice the mass of all the other planets combined. Striped in glowing yellow-orange and blue-gray, it floats in space like a bright-coloured rubber ball. It has a huge red " eye " in its southern hemisphere and spins more than twice as fast as Earth.

The Pioneer mission aims at a number of other firsts. Pioneer F is expected to make the first reconnaissance of the Asteroid Belt between the orbits of Mars and Jupiter. It is planned to be the first man-made object to escape the solar system, and the first to use the orbital velocity and powerful gravity of Jupiter for this escape. It is also the first US spacecraft to draw its electrical power entirely from nuclear generators, four radioisotope thermoelectric generators (RTGs) developed by the US Atomic Energy Commission.

The launch itself was spectacular. The Atlas-Centaur rocket drove the spacecraft away from the Earth initially at 51,800 kilometres per hour -- faster than any man-made object has flown before. For the first week, it travelled an average of 800,000 kilometres a day. It passed the Moon's orbit in about 11 hours.

Pioneer's 13 scientific experiments are expected to provide new knowledge about Jupiter and many aspects of the outer solar system and our galaxy. It will return the first close-up images of Jupiter, and will make the

(Continued on page 22)



JUPITER

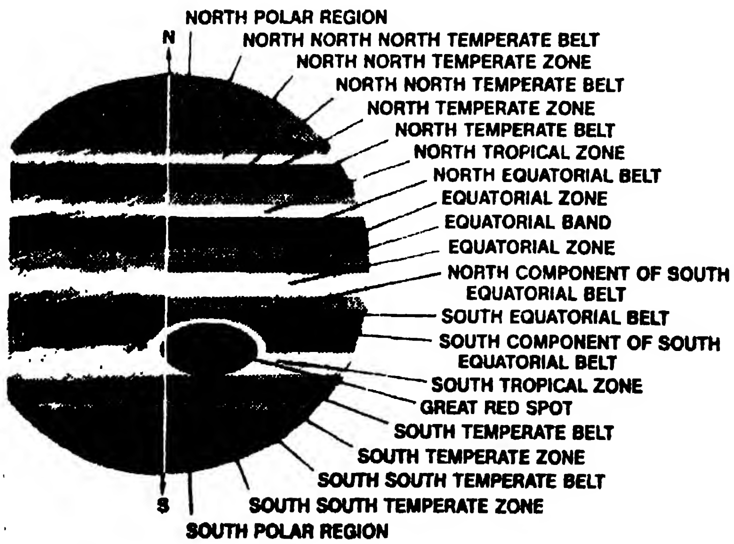
What we know

THOUGH many mysteries concerning this big, brilliant planet remain to be solved, hundreds of years of astronomical observations and analysis have provided a stock of information. Galileo made the first telescopic observations and discovered Jupiter's four larger moons in 1610.

Seen from Earth, Jupiter is the second brightest planet, and fourth brightest object, in the sky. It is 773 million kilometres from the Sun, and circles the Sun once in just under 12 years. The planet has 12 moons, the four outer ones in backward orbit from the direction most moons go. Two of the moons, Ganymede and Callisto, are about the size of the planet Mercury. Two others, Io and Europa, are similar in size to the Earth's Moon.

Jupiter completes a rotation once every 10 hours, the shortest day of any of the nine planets. Because of Jupiter's size, this means that a point at the equator on its visible surface (cloud tops) races along at 35,400 km/hr compared to a speed of 1600 km/hr for a similar point on Earth. This tremendous rotational speed (and fluid character of the planet) makes Jupiter bulge at its equator. Jupiter's polar diameter of about 124,000 kilometres is 19,000 kilometres smaller than its equatorial diameter of about 143,000 kilometres.

JUPITER'S VISIBLE SURFACE



Jupiter's visible surface (cloud top area) is 62 billion square kilometres. The planet's gravity at cloud top is 2·36 times that of Earth. The mass of the planet is 318 times the mass of Earth. Its volume is 1,000 times Earth's. Because of the resulting low density (one-fourth of the Earth's or 1·3 times the density of water), most scientists are sure that the planet is made up of a mixture of elements similar to that in the Sun or the primordial gas cloud which formed the Sun and planets. This means there are very large proportions (at least three quarters) of the light gases hydrogen and helium. Scientists have identified hydrogen, deuterium (the heavy isotope of hydrogen), methane (carbon and hydrogen), and ammonia (nitrogen and hydrogen) by spectroscopic studies of Jupiter's clouds.

Seen through a telescope, the lighted hemisphere of Jupiter (the only one seen from the Earth) is almost certainly a view of the tops of gigantic regions of towering multi-coloured clouds. Over all, due to its rotation, the planet is striped or banded, parallel with its equator, with large dusky, gray regions at both poles. Usually between the two polar regions are five permanent, bright salmon-coloured stripes, known as Zones, and four darker, slate-gray stripes, known as Belts — the South Equatorial Belt, for example. The planet as a whole changes hue periodically, possibly as a result of the Sun's 11-year activity cycles. The Great Red Spot in the southern hemisphere is frequently bright red, and since 1665 has disappeared completely several times. It seems to brighten and darken at 30-year intervals. Scientists agree that the cold tops in the zones are probably largely ammonia vapour and crystals, and the gray polar regions may be condensed methane. The bright cloud Zones have a complete range of colours from yellow and delicate gold to red and bronze. Clouds in the Belts range from gray to blue-gray.

In addition to the Belts and Zones, many smaller features — streaks, wisps, arches, loops, patches, lumps, and spots — can be seen. Most are hundreds of thousands of kilometres in size. Circulation of these cloud features has been identified in a number of observations. The Great Equatorial Current (the Equatorial Zone), 20 degrees wide, sweeps around the planet 410 km/hr faster than the cloud regions on either side of it, and is like similar atmospheric jet streams on Earth. The South Tropical circulating current is a well-known feature, as is a cloud current which sweeps completely around the Great Red Spot.

When Jupiter passed in front of stars in 1953 and again in 1971, astronomers were able to calculate roughly the molecular weight of its upper atmosphere by the way it refracted the stars' light. They found a molecular weight of around 3·3 which means a large proportion of hydrogen (molecular weight 2) because all other elements are far heavier. (Helium is 4, carbon 12, and nitrogen 14.) Under Jovian gravity, atmospheric pressure at the cloud tops is calculated to be up to ten times one atmosphere on Earth. The transparent atmosphere above the clouds can be observed spectroscopically and in polarised light. It is believed to be at least 60 kilometres thick.

Magnetic fields and radiation belts

Among the nine planets only Jupiter and Earth are known to have magnetic fields. Evidence for

Jupiter's magnetic field and radiation belts comes from its radio emissions. The only phenomenon known that could produce the planet's decimetric (very high frequency) radio waves is trapped electrons gyrating around the lines of such a magnetic field. When such electrons approach the speed of light, they emit radio waves. Radio emissions indicate that Jupiter's magnetic field is toroidal (doughnut-shaped) with north and south poles like the Earth's. It appears around 20 times as strong as Earth's field and presumably contains high energy protons (hydrogen nuclei) and electrons trapped from the solar wind. The field's centre appears to be near the planet's axis of rotation and south of the equatorial plane. Jupiter's powerful magnetic field can hold more particles trapped from the solar wind than can Earth's field, and it can increase particle energies. As a result, particle concentrations and energies could be up to a million times higher than for Earth's radiation belts, a flux of a billion particles or more per square centimetre per second.

Because Jupiter has such high gravity and is so cold at the top of its atmosphere, the transition region between dense atmosphere and vacuum is very narrow. As a result, the radiation belts may come much closer to the planet than for Earth.

Radio signals

Earth receives more radio noise from Jupiter than from any source except the Sun. Jupiter broadcasts three kinds of radio noise: (1) thermal — from the temperature-induced motions of the molecules in its atmosphere (typical wavelength 3 centimetres); (2) decimetric (centimetre range) — from the gyrations of electrons around the lines of force of the planet's magnetic field (typical wavelength 3 to 70 centimetres); and (3) decametric (up to 10s of metres) — believed to be from huge discharges of electricity (like lightning flashes) in Jupiter's ionosphere (wavelength 70 centimetres to 60 metres).

The powerful decametric radio waves originate at known longitudes and have been shown to be related to passages of Jupiter's close moon, Io, whose orbit is 2·5 planet diameters, 350,000 kilometres above the tops of Jupiter's cloud layer. Some scientists believe that conductivity of Io is sufficient to link up magnetic lines of force to the planet's ionosphere, allowing huge electrical discharges of built-up electrical potential. The power of these regular decametric radio bursts is equal to the power of several hydrogen bombs. Their average peak value is 10,000 times greater than the power of Jupiter's decimetric signals.

Temperature

The average temperature at the tops of Jupiter's clouds appears to be about — 145 degrees C. based on many observations of Jupiter's infrared radiation. But recent stellar occultation studies indicate that much of the diffuse outer atmosphere is close to room temperature, and that the top layer is at about 20 degrees C. Only about 1/27th as much heat from the Sun arrives at Jupiter as arrives at Earth. Recent infrared measurements made from high altitude aircraft suggest that the giant planet radiates about 2·5 to three times more energy than it absorbs from the Sun. The question is, what is the source of this energy? The shadows of Jupiter's moons on the planet appear to measure hotter than surrounding sunlit regions.

The unknowns

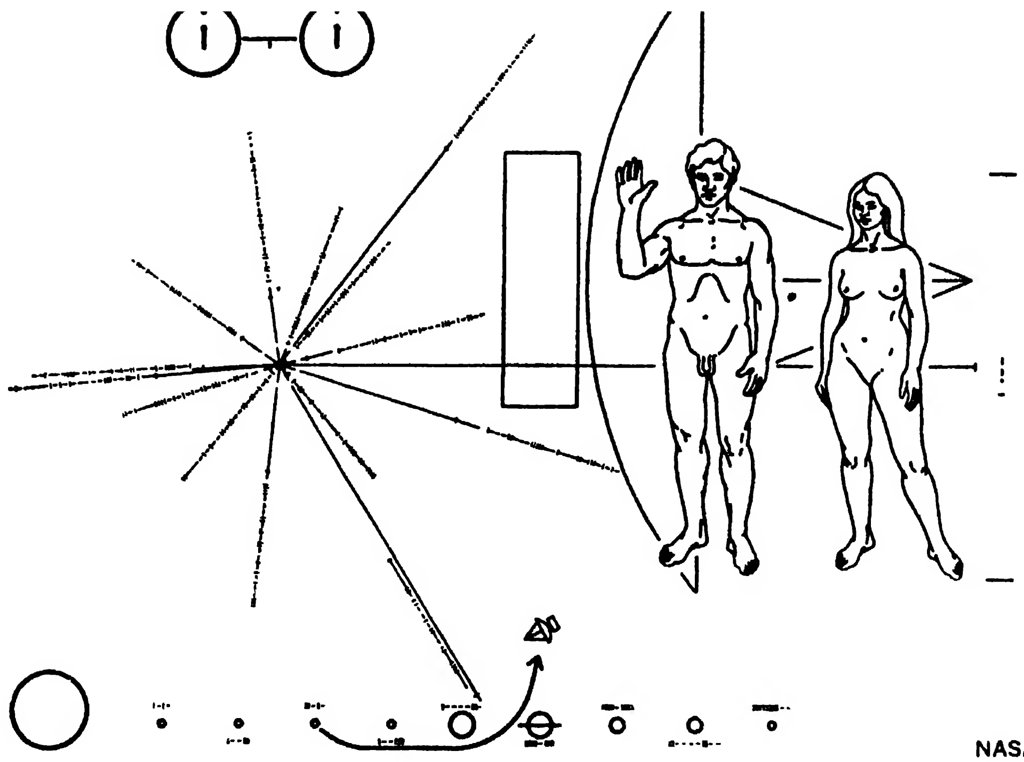
Scientists are reasonably sure of most of the preceding phenomena and observations, though it will be important to check them at close range with Pioneer F. They have few explanations of these observed phenomena, and they know very little about other aspects of the planet. What is hidden under the heavy Jovian clouds? How intense are the radiation belts? Most of the statements which follow are scientific guesses or very general approximations.

Perhaps the most intriguing unknown is the possible presence of life in Jupiter's atmosphere. Estimates of the depth of the Jovian atmosphere beneath the cloud layer vary from 100 to 6,000 kilometres. The compositions and interactions of the gases making up the atmosphere are unknown. If the atmosphere is deep, it must also be dense. By one estimate, with an atmospheric depth of 4,200 kilometres, pressure at the Jovian " surface " would be 200,000 times Earth's atmospheric pressure due to the total weight of gas in the high Jovian gravity. One source cites eight different proposed models of Jupiter's atmosphere.

However, scientists do appear to agree on the presence of liquid water droplets in the atmosphere. Since the planet is believed to have a mixture of elements similar to that found in the Sun, it is almost sure to have abundant oxygen. And most of this oxygen has probably combined with the abundant Jovian hydrogen as water. If large regions of Jupiter's atmosphere come close to room temperature, both liquid water and water ice should be present. Jupiter's atmosphere contains ammonia, methane, and hydrogen. These constituents, along with water, are the chemical ingredients of the primordial " soup " believed to have produced the first life on Earth by chemical evolution. On this evidence, Jupiter could contain the building blocks of life.

Some scientists suggest that the planet may be like a huge factory turning out vast amounts of life-supporting chemicals (complex carbon-based compounds) from these raw materials, using its own internal energy. If so, life could exist without photosynthesis. Any solar photosynthesis would have to be at a very low level since Jupiter receives only 1/27th of Earth's solar energy. It would probably be low energy life forms at most (plants and microorganisms) because there is believed to be no free oxygen. Life forms would float or swim because a solid surface, if any, would be deep within Jupiter at very high pressures.

In the language of the stars


NASA

IS Pioneer F likely to meet extraterrestrial beings? Maybe there's a remote chance. This prompted NASA to attach a unique plaque to the spacecraft that would tell — in the astral language — where it came from.

Annodised with erosion-resistant gold for longer life, the plaque measures 15 cm × 23 cm and was designed by two Cornell University astronomers — Carl Sagan and Frank Drake. The central illustration shows two earthlings whose height is shown by the scale-drawing of Pioneer behind them. Any extraterrestrial physicist would catch on to the dimensional clue at top left which shows an atom of hydrogen — the most abundant element in the universe — undergoing a change of energy state (shown by the different orientations of the orbiting electrons on the circle).

The hydrogen atom is also used as a " universal yardstick " for sizing the human figures and outline of the spacecraft. The hydrogen wavelength — 21 cm — multiplied by 8 (whose binary representation appears next to the woman) gives her height, 168 cm. The radiating lines on the left represent 14 specific pulsars, arranged to indicate our Sun as the home star of the launching civilisation. The symbols at the ends of the lines are binary numbers that represent the frequencies of these pulsars at the time of launch of Pioneer F relative to that of the hydrogen atom at top left. The hydrogen atom is thus used as a " universal clock " too, and the regular decrease in the frequencies of the pulsars will enable another civilisation to determine the time since Pioneer F was launched. The 15th line extending behind the humans, indicates the distance of their star from the centre of the galaxy. Across the bottom are the planets, ranging outward from the Sun. It shows Pioneer arcing away from the third planet Earth, sweeping past the fifth planet Jupiter and then veering off to interstellar space.

(Continued from page 19)

first measurements of Jupiter's twilight side, never seen from the Earth. The spacecraft will also test out the hazards of cosmic debris in the Asteroid Belt. It will probe Jupiter's radiation belts, which could cripple or destroy a spacecraft approaching too closely. The belts are estimated to be as much as one million times more intense than Earth's Van Allen radiation belts.

Jupiter is so far away that radio messages moving at the speed of light will take 45 minutes to reach the spacecraft there, with a round trip time of 90 minutes. This will demand precisely planned command operations. Although Pioneer can store five commands, it will be controlled mostly by frequent instructions from Earth. To carry out the mission, the advanced communications technology of NASA's Deep Space Network (DSN) will be strained to the limit. The DSN's 64-metre " big dish " antennas, one of which now hears the Mariner 9 spacecraft in Mars orbit, will have to hear seven times as far as Pioneer approaches Jupiter. Pioneer's eight-watt signal, transmitted from Jupiter, will reach DSN antennas with a power of 1/100,000,000,000,000,000, watts.

Collected for 19 million years, this energy would light a 7·5-watt Christmas tree bulb for one-thousandth of a second.

Pioneer F is a new design for the outer solar system, but it retains many tested sub-systems of its predecessors, the Pioneer 6 to 9 spacecraft. All four are still operating in interplanetary space. Pioneer 6 is in its seventh year. The 260-kilogram Pioneer F is spin-stabilised, giving its instruments a full-circle scan. It uses nuclear sources for electric power because solar radiation is too weak at Jupiter for an efficient solar-powered system. Its 2·75-metre dish antenna will be locked on the Earth like a big eye throughout the mission — changing its view direction as the home planet moves to and fro in its orbit around the Sun. The entire flight path is in, or very close to, the plane of Earth's orbit, the ecliptic.

How much do we know about Jupiter? Very little, in fact. It broadcasts predictably modulated radio signals of enormous power. Though it has only 1/1000th the mass of the Sun, it may have Sun-like internal processes, apparently radiating about four times as much energy as it receives from solar radiation. In addition to helium, the planet's atmosphere contains ammonia, methane, hydrogen, and probably water, the same ingredients believed to have produced life on Earth four billion years ago.

The most bizarre feature of the planet is the Great Red Spot, known as the "Eye of Jupiter". This huge oval is 48,000 kilometres long and 13,000 kilometres wide, large enough to swallow up several Earths with ease. The Red Spot may be an enormous standing column of gas, or, says one scientist, a "raft" of hydrogen ice floating on a bubble of warm hydrogen in the cooler hydrogen atmosphere, and bobbing up and down at 30-year intervals, so that the Spot disappears and reappears.

One important benefit of the Pioneer Jupiter mission and others like it will be increased knowledge of "collisionless plasmas" of the solar wind. This bears directly on the "ultimate" clean system for electric power production, controlled hydrogen fusion. The findings may also lead to better understanding of Earth's weather cycles, and to insights into Earth's atmosphere circulation through study of Jupiter's rapidly rotating atmosphere.

Pioneer F spacecraft will carry a 30-kilogram experiment payload. It will make 20 types of measurements of Jupiter's atmosphere, radiation belts, heat balance, magnetic field, moons, and other phenomena. It also will characterise the heliosphere (solar atmosphère); perhaps the

The Asteroids

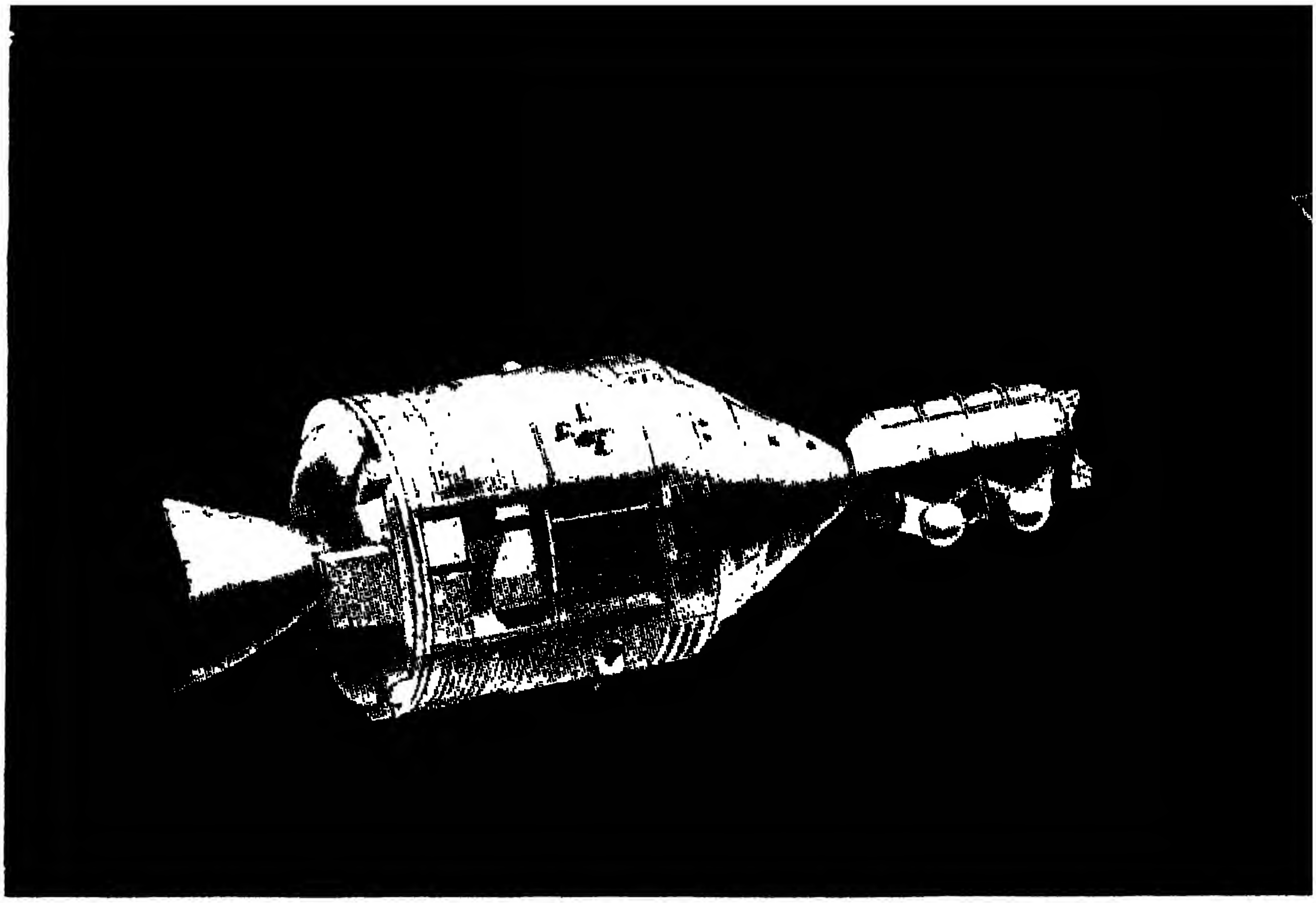
The asteroids travel around the Sun in elliptical orbits like small planets. The Asteroid Belt lies between the orbits of Mars and Jupiter, between distances from the Sun of 270 million to 555 million kilometres. The Belt is a region roughly 280 million kilometres wide circling the Sun and extending about 40 million kilometres above and below the plane of the Earth's orbit. Scientists believe the asteroids condensed individually from the primordial gas cloud which formed the Sun and planets, or that they are debris from the break up of a very small planet. There is estimated to be enough material in the Belt to make a planet with a volume about 1/1000th that of the Earth. Astronomers have identified and calculated orbits for 1,776 asteroids, and there may be 50,000 in the size range from the largest 770-kilometre diameter Ceres, down to bodies 1·5 km in diameter.

Passage of Pioneer Jupiter through the Asteroid Belt will allow the first survey of the density of asteroids too small to be seen by telescopes and of fragments and dust in the Belt. This will be of scientific interest but is even more important to exploration missions. Since the Belt is too thick to fly over or under, all outer planet missions must fly through it. And assessment, by an actual flight, of the Belt's hazard to future spacecraft will be the first consideration.

In addition to asteroids, the Belt is presumed to contain hundreds of thousands of asteroid fragments, and uncountable billions of dust particles ranging down to millionths and billionths of a gram. Two zones of heavier concentrations of fragments and dust are believed to exist at distances from the Sun of 400 and 480 million kilometres.

In the center of the Belt, asteroids and particles orbit the Sun at about 17 kilometres per second. These particles would impact the spacecraft (which has its own velocity in somewhat the same direction) at about 48,000 km/hr. In short, asteroidal material is thinly spread, but penetrating.

A few asteroids stray far beyond the Belt. Hermes can come within about 350,000 kilometres of the Earth, or closer than the Moon. Icarus, another asteroid comes to within 15 million km of the Sun.



interstellar gas; cosmic rays; asteroids; and meteoroids between the Earth and 2·4 billion kilometres from the Sun.

Cost of two Pioneer Jupiter spacecraft, scientific instruments, and data processing and analysis is about $100 million. This does not include cost of launch vehicles and data acquisition. A second, almost identical spacecraft, Pioneer G, will be launched to Jupiter in early April of 1973.

Although Pioneer's objective is to make measurements of Jupiter, it is possible that some "bonus" data will be obtained after leaving the planet. The most interesting experimental questions beyond Jupiter will be: what is the flux of galactic cosmic rays and the distribution of neutral hydrogen, non-solar-wind plasmas and interstellar hydrogen and helium? What do these tell about the interstellar space beyond the boundary of the heliosphere (the Sun's atmosphere)? Of equal interest will be the search for the heliosphere boundary itself, "where the solar wind stops blowing" and interstellar space begins. The plasma, magnetic field, high energy particle, and ultraviolet photometer experiments will share these two searches. ■■

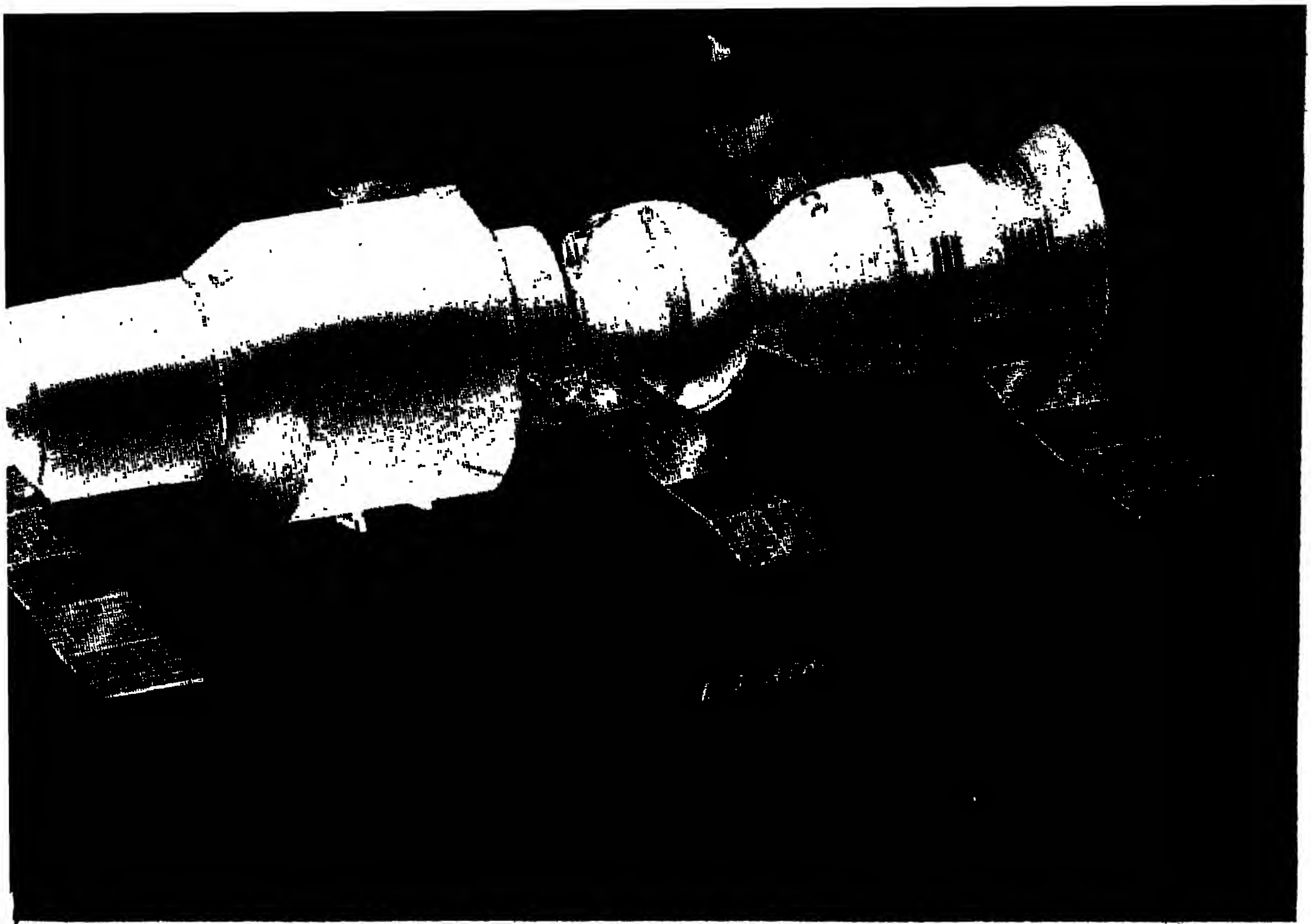
Joint US

AMERICAN astronauts and Russian cosmonauts in the same spacecraft? It may sound a little too good to be true. But it's going to happen in June 1975 if the Russians say yes to an American plan.

The plan is no pipedream of US space engineers. The idea of linking Apollo and Salyut/Soyuz spacecraft in Earth orbit for two days was chalked out less than a year after US and Soviet space engineers began meeting to devise a docking mechanism for such a mission. The formal announcements may be made during President Nixon's Moscow trip in May.

This is how the flight plan has been sketched out:

1. A Russian Salyut space station will be launched into Earth orbit around 10 June 1975.



Artist's concept of Apollo spacecraft nearing the Soviet Salyut/Soyuz prior to docking. Apollo will have the active role in approaching and initiating final hook-up manoeuvres

USSR Space Docking

2. A day later, a Soyuz spacecraft manned by three cosmonauts will be launched to rendezvous and dock with Salyut.

3. An Apollo spacecraft will be lifted from Cape Kennedy three days later to go into a 100 × 81 nautical-mile orbit.

4. After a day, on 15 June, the Apollo will circularise its orbit to 162 naut-mile and will rendezvous and dock with the Salyut/Soyuz.

5. They will remain docked for 2 full days during which astronauts and cosmonauts will visit one another's spacecraft and carry out simple experiments. Then the Apollo will undock and remain in Earth orbit on an 11-day earth resources survey mission.

A second docking planned for 1976 may last for two weeks.

The docking module

The most important feature in the joint mission is the docking module. It will be a tank-like structure 1·5 metre in diameter and 3 metre long with pressurisation. Pressurisation is a must because Russian spacecraft operate in Earth orbit at surface atmospheric pressure (using a combination of nitrogen and oxygen). Apollo, on the other hand, has an atmosphere of pure oxygen at 5 psi.

The docking module will have on one end the same docking mechanism used by the Moon — landing lunar and command modules; on the other end, it will have a Russian docking ring. During launch, the module will sit atop the Saturn's upper stage (the same way the lunar module does). The docking initiative will lie with the Apollo. ■■

MORE ON MARS

V. S. VENKATAVARADAN

MARS, the first planet to lie outside the orbit of the Earth, has been an interesting object from the point of view of planetary physics and exobiology (the study of life in extraterrestrial objects ; see SCIENCE TODAY, February 1972). It is also the most likely candidate for manned exploration after our own satellite Moon.

The exploration of Mars by space probes began with Mariner 4 sent towards the planet on 28 November, 1964. This gave many close-up pictures of Mars showing details such as the impact craters. It also showed that its magnetism is less than 1/3000th of the Earth. Later Mariner 6 and 7 also gave information about the surface and atmospheric conditions of the planet. These missions were of the fly-by type. Mariner 9, in contrast, is an orbital mission where the spacecraft has become an artificial satellite of Mars.

The major aim of the US Mariner 9 mission is to map about 70 per cent of the surface of Mars and to choose favourable landing sites for the future Viking mission (1975). Mars 2 and Mars 3 of the Soviets did send landing equipments to the surface of the planet. But while Mars 2 and Mars 3 orbiters are functioning well, the landing equipments have failed to give any information. Mariner 9's orbit has a minimum distance of about 1,400 km (periapsis) and a maximum distance (apoapsis) of 17,050 km. Even at the farthest distance, the observation of Mars by Mariner 9 can be compared to seeing a person face to face at arm's length as against the observation from the Earth which is equivalent to observing the person from a distance of 5 km. Basically Mariner is carrying out two types of studies — geological and atmospheric. The atmospheric studies are intimately connected with finding evidences for the possibility of life on Mars.

Dust storm

As the Mariner and Mars spacecraft were approaching Mars, a dust storm which originated on 22 September 1971 covered the whole surface by 25 September. Even though it was disadvantageous from the point of view of surface photography, it could also be used to advantage for studying the surface features at each stage as the dust storm subsided. Dust storms which can be observed even by Earth-based telescopes are rare phenomena, occurring once in about 15 years. The most recent one was in 1956 which lasted about 3 weeks. Dust storms of two-month duration occurred in 1877 and in 1924. The present dust storm had a height of about 40 km. In the case of Earth, the storms are activated by the energy derived from the condensation of water vapour and the consequent release of latent heat. Mars with no visible liquid surface would provide a laboratory model of how a large storm disperses in the absence of water.

Upper atmosphere

During the period of dust storms, Mariner 9 studied the upper atmosphere (since the dust storm did not disturb the region above 40 km). The temperature of the upper atmosphere was found to be about 350°K (77°C) with a 10 to 20 per cent range of temperature variation in the region of 100–250 km altitude. Atomic hydrogen and atomic oxygen were observed in the upper atmosphere. Whereas the hydrogen content is similar to the Earth's upper atmosphere, substantially less amount of oxygen was observed. These gases are presumably produced by the dissociation of water by ultraviolet rays.

Water has been observed in the atmosphere above the south polar region. The quantity is not known but expected to be small. The white

cap in this region is presumably frozen carbon dioxide. Fresh surface features have emerged from the frost cover since Mariner 9 arrived indicating that the cap is only a few centimetres thicker.

Lower atmospheric regions showed a constant temperature profile whereas a variation of 3°C/km was expected. This is attributed to the dust storm which acts as a blanket equalising the temperature. The mean atmospheric pressure is found to be 5·5 millibar as against the terrestrial atmospheric pressure of 1013 millibar (1 millibar is the pressure exerted by a weight of one gram in a square centimetre area).

The martian ionosphere is found to be 10 km higher than it was in 1969 (135 km in 1969 as determined by the fly-by mission against 145-150 now) probably due to the dust storm.

Geology

The martian surface is somewhat similar to the lunar landscape but more complex. The surface is pitted with a large number of craters — possibly of both meteoritic and volcanic origin. Fissures, cracks and rilles similar to those on the Moon have been observed. However, the rilles seen in the case of Mars are accompanied by tributaries (unlike on the Moon) adding support to the theory that liquid water which was present in the earlier geological period was responsible for these features.

The most remarkable yet unexpected finding about the features of the martian surface is that erosional processes have been operating in magnitude. For instance the large *Hellas* region of Mars is the site of a perpetual dust storm. It was found that the region seems to contain fewer craters or other surface features as compared to the observations by Mariner 6 and 7 in 1969. This shows that within a period of two years, the surface has undergone rapid changes of a high magnitude. Among the craters on the surface, the densely clustered craters (50-100 km diameter) may be of impact origin. There are isolated craters which show evidence of volcanism. Of particular interest is a huge crater of about 500 km diameter, Nix Olympica, showing typical volcanic features.

Parallel rilles whose length exceeds more than 1500 km are clearly seen. Sinuous rilles showing remarkable similarity to the terrestrial stream erosion patterns are also seen with many branching tributaries. The martian surface is also covered with ridges and mountains with altitudes varying over a wide range — about 13 km.

Some regions are also found to be warmer than the neighbouring regions. These so-called 'hot spots' could be due to internal activity and if confirmed will show that the interior is still volcanically active. Again, both Mariner and terrestrial observations point to the recent formation of dark blotches which are attributed to the settling dust.

Surface composition

From infrared interferometric studies it has been concluded that the surface has a wide range of materials mainly silicates with some regions comprising pure quartz.

The gravitational field of Mars is found to be uneven and mass concentrations or *mascons* similar to those found on the lunar surface are attributed to as the cause for the observed

Dark irregular areas seen in the Phaethontis region by Mariner 9 cover much of Mars' south temperate zone (these were not evident in the Mariner 7 photos of 1969). These areas may be the "dark nuclei" seen by observers on Earth. Some of the dark areas are contained within the craters, others wash over the craters

anomalies. These *mascons* could be huge meteorites buried below the surface. An equatorial bulge of about 1 to 2 km is found at about 110° W longitude. The bulge is repeated at about 180° on the other side of the planet with depression of the equatorial regions in between the bulges. This was one of the unexpected findings and the riddle is yet to be answered.

One of the major objectives of Mariner 9 is to find out suitable location for the future Viking landing mission. A warm region at low altitude for favourable entry using parachutes and a region with moisture to look for evidence of life are the primary criterion for the landing site.

Satellites

When Mariner 9 photographed the two martian satellites, *Phobos* and *Deimos*, they too were found to be pitted with a large number of craters. The craters indicate their long age as well as their high strength. Phobos has a height of 21 km and a width of 25 km ; Deimos is estimated to be 12 km high and 13·5 km wide. Their uneven sizes point out to the possibility that they were once captured from the asteroidal belt.

As mentioned earlier, the Soviet Mars 2 and Mars 3 missions sent equipment to the planetary surface. Mars 2 had expelled an emblem of sickle and hammer towards the surface and an experiment package from Mars 3 soft-landed on the martian terrain. However, it stopped signalling 20 seconds after landing. The failure could be due to the heavy winds which could have damaged the equipments. An alternative possibility is that it sank into the dust.

The aims of Mars 2 and Mars 3 are to get enough data on the martian surface so as to place on the surface a *Planetokhod* or a planet walker. The Mars-walker would not be driven from Earth as was the case with the Lunokhod. It would contain on-board sensors to avoid hazards on the martian surface. It takes a few minutes even for radio communication waves from Mars to reach the Earth. Hence any urgent problem arising due to hazards in the Martian surface has to be solved there itself immediately and it may be too late if an instruction is to be received from the Earth.

The observations so far on Mars clearly indicate that the planet is geologically and meteorologically alive. Whether it is biologically alive too will be answered only after a more detailed observation of the surface.

Latest Mariner 9 photo shows sinuous rilles that look like stream erosional patterns on Earth. In the centre the pattern resembles lunar rilles, though the branching tributaries at left are not found on the Moon. Mariner 9 infra-red spectral data indicate there is little water on Mars now, but the valleys could have had abundant water in the past. The valley shown here is 400 km long and 5-6 km wide, and is like a giant version of a terrestrial arroyo, a water-cut gully found in mountains in the arid south-western USA

BLURS & BRIGHT SPOTS

If science and technology are the keys to progress, the problem is in choosing the right one. Are the developing countries free to choose the right technology? Or, are they, by grabbing aid in impatience, turning the key for some one else?

The giver takes all!

WHEN Peru was in serious financial trouble in 1967, the US sent a mission to discuss an aid programme. After prolonged talks, Peru rejected aid. Not that it didn't need help. But, if it accepted the loan, Peru would have to buy inferior and more expensive US planes instead of the French supersonic Mirages which it had long planned to buy. It would also have to allow US ships to fish within a 320-km limit off Peru where it sought to control fishing in off-season to save some stocks. Also Peru would have to refrain from taking over an oilfield whose ownership had been disputed by a US oil firm.

That's how the advanced countries use aid to exploit the developing countries technologically, as a study, *Aid as Imperialism*, by Teresa Hayter so glaringly points out. One could add more examples. When you have an advanced technology, when you hold the keys to prosperity, and when others are impatient or gullible, you need have no regrets that colonialism is a dying creed. Like when tons of old and unsold stocks of streptomycin were dumped on Pakistan some years ago. Or when, after refusing to share the centrifuge technique of uranium separation for 20 years, the US offered it to some developing countries, because they were on the verge of developing a better process that would have made the US technique obsolete (see SCIENCE TODAY, October, 1971).

Teresa Hayter was a research staffer at the Overseas Development Institute, London. In 1967, she was sent to Latin America for a World Bank-financed study of how aid benefited those countries. What she found there came as a shock, that aid was basically used to promote the interests of the donors slyly and subtly, and if need arose, openly. One would have expected the international agencies, the International Monetary Fund and the World Bank, to be above board. But behind their professed altruism, they too served the major powers' purpose. When the Bank got wind of what Teresa had to say, she was summoned to an interview and told to give up the research and write "something else". Teresa wouldn't budge. The Bank then tried to suppress the report, and having failed, refused to publish it.

Yet, only a few months ago, President Nixon was droning: "We need to find the most effective way to help the poor nations...". That was the State of the World Message. But Uncle Sam was deluding himself, playing the Good Samaritan's role. Maybe, the apparent benevolence will warm up some simple souls, and a few may even applaud the gesture. Self-deception is only natural when you are inhibited by your commitments, by your own rhetorics. But the fact is that to keep an industrial society going at a peak production level, you need to find new markets, beyond your own frontiers. You must also ensure that the markets are available forever. Aid, subtlety and some sophistry become useful tools.

Teresa gives an example of how the international agencies are dominated by the US. In November 1966, when President Lleras of Colombia, a liberal, refused to devalue the peso during a financial crisis "because foreigners told him to", not only did the agencies with-

"A leading American role in world affairs continues to be indispensable to the kind of world our own well-being requires.'

UNITED STATES OF AMERICA

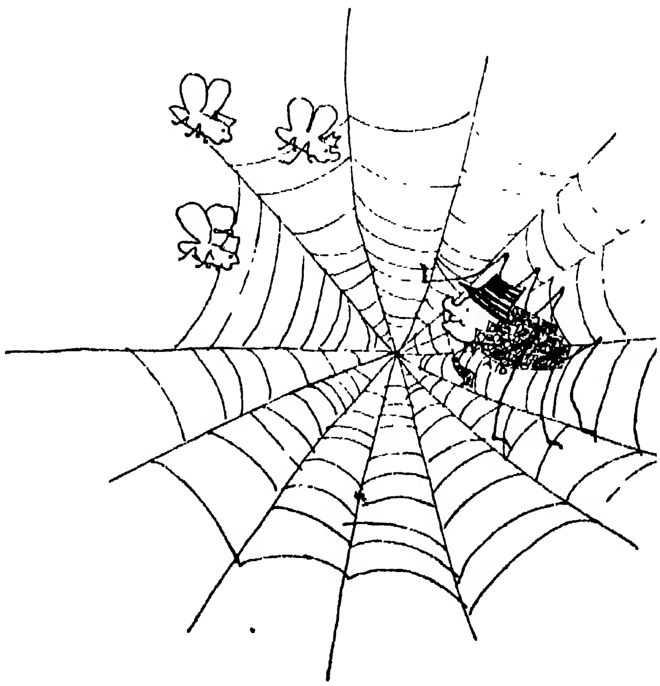
"We need to find the most effective way to help the poorer nations.... Our wealth, our humanitarian traditions, and our interests dictate that we have an active foreign assistance programme."

RICHARD M. NIXON, PRESIDENT OF THE UNITED STATES OF AMERICA

draw support but the World Bank even told the New York banks to stop lending to Colombia. The agencies acted in concert. Their meeting was held in the US embassy. And, according to one IMF version, the initiative came from the embassy. "The IMF representative merely acted as a spokesman, following instructions from the embassy and Washington." Finding President Lleras tough and unrelenting, the agencies tried to mend the fence. Negotiations started, and this time the US told the IMF not to be tough ! Teresa says the Bank had also claimed devaluation in India as its "one clear success in exercising leverage", but it got the statement deleted.

Aid from the US comes generally in goods. But the goods must be bought from the US. This helps in dumping second-hand goods and technology on others. Not just that. The goods must also come in US ships. Further, under the Hickenlooper Amendment, you cannot get aid if you nationalise US assets without taking appropriate steps (which can include compensation or arbitration) within six months. In this latter case, you may not get aid from the World Bank too. You have to settle the foreign investors' claims which the Bank thinks should be settled. To get a project aid from the Bank, it must not only approve the project but the country's general economic policies too ; the institutional framework, import and export policy, attitude to private and foreign investors, etc should be acceptable to the Bank. And a good project could be rejected because the country's general policies are not "conducive to economic development and investment", as judged by the Bank, of course. Thus the Bank refused to commit aid to the populist government of President Rojas Pinilla in Colombia from 1956 to 1958, to Argentina under President Illia, to Bolivia for a period after the 1952 revolution, and to Cuba, for obvious reasons. In Brazil, the Bank stopped lending to President Goulart's government from 1962 to 1964 — his economic policies included redistribution of land and income. Aid was promptly resumed later when a military government took over. That the new regime showed little concern for social reform, educational changes, land tenure, etc, did not bother the US or the agencies.

On the surface, the Bank's policies look innocuous. Aren't they in the developing countries' interest? But they also involve certain basic values and social priorities of a society. To qualify for aid, one must also accept the values and objectives of the donors. What



the developing countries need today are more food, jobs, houses and medical facilities, and the application of science and technology to raise the general condition of living. These receive little attention on the donors' list. And development is sought mainly in areas where they would benefit the donors in the long run. The Bank's economic policies, while it brought temporary stability in some countries, neglected the rural and urban problems. It attracted mass migration to cities and created large slums. But the Bank officials, Brazilians told Teresa, " were oblivious to the sight of people sleeping on the streets ". One had to provide figures to prove the point! (Mr. MacNamara, the World Bank president, who came to India in January this year, admitted that the Bank's development programmes in India had bypassed the poorer sections.)

The agencies' main concern, Teresa found, was stability and order. Aren't they essential for growth? they argue. Yes, and they are also essential so foreign investors can invest without much risk and profits can flow back home. So also the system functions smoothly, because you have so much to sell. And since so much is at stake, it is also necessary to support the "right" government and the "right" man within a government: one can always trust the right man to do the right things and prompt others do them too. Aid was withheld from Argentina till the "right man", Dr. Keiger Vatena, was appointed the Finance Minister.

Now the other side of the story. When Teresa submitted a draft of her report to the ODI (which was responsible for its publication), the IMF and the Bank, they were all rather stung. The ODI thought it was set in an " ideological framework ", and it was not the ODI's intention to give any such colour; the report needed some changes so only the facts are given accurately and objectively. The IMF rejected the draft totally; it would help neither the IMF nor the developing countries. The Bank thought the study was distorted, unbalanced and biased, and should be rewritten.

Teresa rewrote the report " front to end " to give more importance to the activities and views of the agencies than to her conclusions, which were now shifted to the end. The new draft was " very much more convincing ", the ODI said, but only the " glowing " section on Cuba should go. (Teresa had talked how Cuba had banished unemployment *without* US aid after the revolution.) This section too was rewritten. The ODI director now told Teresa that he would send the new draft to the agencies for their comments, but since he didn't expect any major changes, she could go ahead and make arrangements with the publishers.

The agencies, however, had new objections. In the course of her research, Teresa had talked to some of the top agency officials on the purposes and subtleties of disbursing aid. They were rather frank, not suspecting perhaps that Teresa would say such a thing. How could she make such indiscreet use of information given in confidence? Many of the passages in the paper, " whether true or false (and most are false), could seriously embarrass the Bank in its relations with its member countries". The paper, therefore, must not be published.

When the ODI director asked the Bank which part " constituted a breach of confidence ", it wrote back, Teresa was told, that the study revealed information which should not have been revealed. If the ODI did publish the study, or even let Teresa publish it elsewhere, it would be a breach of confidence. The implications were obvious — in the case of publication, the Bank would stop financing the ODI. And the ODI depended on the Bank for funds. So the director asked whether Teresa would let the ODI recast the study without the ideological colour. Teresa refused, and had to find a private publisher (Penguins, fortunately). ■■

Food for peace?

America is not wholly free of the charge of taking advantage of India's difficulties. During India's food crisis of 1965-66, President Johnson rather obviously attempted to use our (US) wheat shipments to persuade India to take a more tolerant view of our military activities in Viet Nam. Determined to demonstrate their sovereignty, the Indians predictably stepped up their criticisms of our bombing of North Viet Nam. Angered, President Johnson responded by slowing down our wheat shipments at the very moment when they were most needed.

-- Chester Bowles, former US Ambassador to India, in "The US and Russia in India", *Foreign Affairs*, July 1971

Economic assistance is one of the instruments of foreign policy that is used to prevent political and economic conditions from deteriorating in countries where we value the preservation of the present government.

-- Prof. H. B. Chenery, former senior economist of the US Agency for International Development

BOOKS

The New East India Companies

The Multinationals by C. Tungendhat (Eyre & Spottiswoode, 1971, £3.25)

THINK: A Biography of the Watsons & IBM by William Rodgers (Panther, 1970, 50 p.)

THE expanding empires of multinational companies wealthier than most countries, with power levels almost constituting indirect parallel governments, is the common theme underlying both the books. The annual budget of the International Business Machines Corporation, popularly known as IBM, is greater than that of many nations " with a share value worth far more than all the gold ever hoarded in the vaults of Fort Knox ". Its phenomenal growth is apparent from the fact that $1 invested in it when it started in 1914 would be worth more than $6,000 today. From a paltry income of an equivalent of Rs. 150 crores around the year India attained independence, its present annual income has exceeded Rs. 7,000 crores.

The awe-inspiring statistics could not be made more picturesque than by comparing the annual sales of multinational commercial empires like IBM with our entire Five Year Plan outlays. Though the annual sales of General Motors exceed our five-year outlay in the current plan, the growth rate of IBM is so enormous that very soon it is expected to become the largest multinational enterprise on earth.

The fact that such a commercial empire on which, it is said, the Sun never sets is the result of the tenacity and genius of one extraordinarily ambitious man calls for genuine admiration even if one may harbour legitimate suspicion about the security of small and developing nations in the face of possible indirect power wielded by so wealthy and talented a corporation. To cite William Rodgers: " The company has become a dynastic empire, in which the qualifications for citizenship were defined by one man and enforced by an everchanging hierarchy of subordinate executives, was ruled for more than forty years by a patriarchal boss, benevolent and tyrannical by turn, a man of great kindness with an intuitive business genius.... Without implying similar motive, one must look to such autocrats as Mao Tse-tung, Hitler, Stalin and perhaps to the papacy for the combination of mysticism, evangelism, nationalism and faith developed by Thomas Watson and transmitted through his corporate domain during his leadership ...... IBM was Watson, and to a diminishing but discernible extent remains so. "

From Rodgers's descriptions and anecdotes one would tend to infer that the two classical motivations governing a multinational company, viz, profit-making and empire-building, were present to an alarming extent in Watson, i e IBM. This dynamism appears to have been worked up almost to a frenzy as is betrayed in its anthem — the now famous *Ever Onward:*

Ever onward — ever onward!
That is the spirit that has brought us fame
We're big, but bigger we will be, ...
We've fought our way through — and new

Multinational commercial empire	Approximate sales in 1970 in equivalent Rs. crores	India's Five Year Plans	Approximate net investment over five years in Rs. crores
Philips (Holland)	3,000	**First Plan**	2,680
IBM (US)	6,500	**Second Plan**	6,100
Standard Oil (US)	12,000	**Third Plan**	10,400
General Motors (US)	24,000	**Fourth Plan**	22,635

Fields we're sure to conquer too
For the EVER ONWARD IBM.

Let alone developing countries like India, the more affluent countries like England, France and Canada are worried too. " What Canadians have worried for years and what General Charles de Gaulle in France helplessly tried to prevent in the case of a French computer manufacturer and what they are writing books about in England, is ' The American take over ' led by IBM ".

It is now plain how their pre-eminent international power is expanding at a pace that can induce fear complexes among their competitors, i e those who are left still, or among the Government officials of 105 countries who place the long-term interests of their country before the short-term interests. They are too good — in research, technology, sales, and public relations, and they " had mastered the arts and sciences of foreign trade, expansion, absentee ownership and management by citizens of each country in which it operated. With a single exception, IBM always kept complete ownership of its overseas production facilities, a policy it was not easy to insist upon."

Having given initial encouragement for want of good technology in the short term, many a national government was taken by surprise at the alarming growth of the enterprise in a relatively short time. Sometimes it seems realisation came too late to put effective check, judging by the observations of Rodgers: " Sometimes the company all but took a country by the scruff of the neck and compelled it to join with others in doing what they might well have collectively accomplished in the first place. . . . By heavy applications of research and capital, or by expanding sales and service efforts, IBM could drive virtually any company, including governments, bent on interfering up against or close to the wall. "

These interesting and thought-provoking books on multinational enterprises have much to convey for a country like India which is dedicated to the progress of its citizens with due regard for not only political freedom but also economic freedom. Perhaps as a rule one should not entertain beyond a safe limit any foreign enterprise whose annual budget is of the same order of magnitude or more as the budget of the country. In the field of computers it might even result in a direct trespass into our economic freedom. At present we have only 150 computers compared to nearly a lakh such in the world. Even with this appalingly small number, subtle pressures might be exerted. A hundred and fifty computers in existence imply about three hundred to four hundred Indian companies have burnt their previous boats to hop into the computer bandwagon. These organisations cannot go back to the old file-and-pen accounting system even in an emergency situation. If computer services are withdrawn suddenly it may unleash a catastrophe in hundreds of companies. In a few years time this number may rise to thousands and perhaps in over a decade to tens of thousands. At that time if a precipitate action is threatened by any monopolistic set up, whether wholly Indian, partially foreign, wholly foreign or multinational, the tens of thousands of dependent Indian companies may face hardship ranging from inconvenience to extinction. The sum total may amount to a national upheaval — a perturbation no government can afford to tackle without losing its equilibrium. Now is the time to think about '*THINK*' or else someone else will do all our thinking for all times to come.

V. S. HIRLE

Dear Red Cloud—this message you are now reading was your dinner !

SPEECH DEFECTS

RAMESH K. OZA

YOU had waited for this day a long time. Your child's first day at school. He comes home and you can't wait to ask him what he did there. He had played, sat in a class, learnt a nursery rhyme. "Gg-gg-goosy-Gg-g-gg. . ." Goosy goosy gander stumbles and falls in its upstair and downstair wanderings. You are surprised but don't give it much thought. It hadn't happened before. It would pass.

But some things don't pass. The goose never comes out whole. Your son stumbles on other words. He becomes a stammerer. Then the fear starts crawling up your throat. Will he stammer all his life ? It is unthinkable. He has been a bright and talkative boy, particularly good at reciting poems. What has gone wrong ?

You take him to a doctor. His tongue, his lips, his palate, his vocal chords — in fact everything that has to do with speaking — gets a thorough checking. But there's nothing the doctor can find wrong. Then he talks to your son and the truth emerges slowly. He had been thoroughly scared, he said, after his parents went away leaving him amongst strangers. It was a traumatic experience for him. Can your child be cured ?

Yes, you have a reason to worry. The spoken word is our most important means of communication. Smooth speech is almost a necessity in earning a living. True, many men of history have had the handicap. Demosthenes, for instance (he is said to have recommended cure by placing a pebble in the mouth and shouting at the waves), or King George VI who had solved his problem to the extent of being able to make broadcasts. Also the Roman emperor Claudius and Somerset Maugham. But not all speech defects can be got over by one's own efforts.

Speech defect is a wide term. A person may be unable to speak in the normal manner for several reasons. It may be physiological, e g, articulation defects, voice problems, cleft palate, cerebral palsy, aphasia. It may also be psychological, the result of some trauma or insecure feeling in early childhood. Some can be cured by therapy, some may not be helped at all.

Almost all speech defects are detectable early. When do you know your child has a speech disorder ? In the early stages of speech development, a child's vocalisations have no set pattern. At this stage, the child's cries and babbles are responses to stimuli — a part of the bodily expression and not a voluntary act. In the second stage, which begins between the sixth and seventh week, the child is aware of the sounds he is making. He finds it pleasurable. In the third stage, he begins to repeat the sounds he hears himself make — hearing and speaking are linked as complementary activities for the first time. Sometime during the ninth or tenth month, begins the fourth stage when a child starts imitating the sounds others make without understanding them. The last stage, by the time the child is one and a half-year old,

Top: A case with vocal nodule, seen more in singers, hawkers, children and adults who shout so often

sees him using sound patterns in a meaningful way.

Words, sound patterns, yes. But sentences, no. The first sounds to come out easily are the front vowel sounds ; the back vowels come later. By 2½ years of age, most vowel sounds are mastered. The first consonants are those that are formed with both lips. When he is 4½ years old, an average child has learned all the consonants. This is the time when you have to watch out for tell-tale signs : weak articulation, poor comprehension, a high-pitched or hoarse voice, speech that is too rapid or nasal, or clear-cut stuttering.

The causes may be congenital, or they may be due to damage suffered by the speech organs in early childhood. However, there is another major factor which is rooted in the psyche. In the very early stage, we have noted, making sounds is a physical response to stimuli. This is the pre-speech development stage and the hurdle may lie in the parent-child relationship. Take the child's body language, for instance. Sucking or smiling or stretching the hands are symbolic gestures meaning hunger or an urge to be held. The mother may ignore these gestures ; if she does it repeatedly, there may be frustration and a gradual reduction in efforts to communicate. If the child gets enough mothering, if his parents respond to his gestures, then he knows his attempts at communication are succeeding and he is keen to learn more.

Take the following case history : " Rita (F/4 yrs) was brought to the clinic with complaint of poor speech development. She was described as stubborn, did not listen to either parent and used to create scenes in front of servants and outsiders causing great embarrassment to the parents. She was described by her teacher as an intelligent and affectionate child." The last entry seems paradoxical, but that is what gave us the clue. We investigated Rita's background thoroughly and it wasn't difficult to find the cause. Rita's father was a strict disciplinarian completely oblivious of the fact that his child was only an infant. Her mother was a working woman, who could spare very little time for the child. The child, left with a caretaker, had grown to be stubborn. It was only in the school or on the playgrounds in the evenings that the little girl felt herself being wanted. The speech disorder was almost a natural corollary.

Normal appearance of the vocal chords during voicing or phonation

When a child starts babbling or repeating sounds, this sets up the neuro-muscular pattern for speech production. This vocal play and exercise helps train the ear through an auditory feedback. The babbling also attracts the

Right: The vocal chords have developed ulcers — due to abuse of voice or chronic infection. This case has a nodule on one side and ulcer on the other chord. Extreme right: Cancer of vocal chords. In such cases the whole larynx is removed and the patient is given speech therapy to learn to talk through " belching "

Appearance of vocal chords in larynx due to chronic laryngitis. Voice becomes hoarse, heavy and at times there may be total loss of voice due to massive inflammation

parents or people around the child, and they, in turn, stimulate the child with different types of sounds and words. The child develops his " vocabulary " by acquiring ' words ' for everything that happens in his immediate environment. But his ability to use appropriate words is limited and very often he has to pause before he comes out with correct words or expressions. This becomes a moment of hesitancy.

Hesitancy is a perfectly normal phase of speech development in a child, but parents are likely to get worried and interpret it as speech hesitancy or stammering, particularly in the case of boys. If, however, they don't display their concern or anxiety about this lack of fluency, the child may well recover and proceed to speak normally. But if corrective steps are taken, or if the child is scolded or nagged (" Speak correctly ", " Take it easy "), you are heading for trouble.

The speech defects

The psychological basis apart, the major causes of defective speech are organic — result of disease, impairment or absence of a particular speech organ. Take the most common one — articulatory disorders. In acute cases, this reduces speech to total unintelligibility. Specific sounds or groups of sounds may be omitted, added, substituted or distorted. One example of articulatory disorder is lalling where *r*, *l*, *t* and *d* sounds are misarticulated, possibly due to poor control of tongue tips. In lisping, misarticulated sibilant sounds, particularly *s* and *z*, are substituted by the *th* sound. One condition of misarticulation is dysarthria which is due to neuro-muscular incoordination. The other, dyslalia, may be due to structural defects in the oral cavity or poor habit. For example, a child with cleft of palate or lip will have not only defective articulation but defective resonance. He may speak through the nose and sound very nasal.

When the defect lies with the voice, the condition is medically known as dysphonia — defect of pitch, loudness and voice quality. The voice may sound too weak or too loud, hoarse, harsh or metallic, strident, husky, broken or falsetto. A high-pitched voice is often caused by psychological tension : the muscles of the larynx are contracted so that pitch is raised beyond its normal range. It may be caused also by a small larynx where the vocal folds are short and thin or by the inability to distinguish between changes in pitch, which also creates monotonous voices and repeated pitch patterns.

Nasality or denasality occurs where the voice quality has suffered, a condition known as rhynolalia. Cleft palate is a prime cause for nasality — the bilateral structures of the palate did not unite during foetal life. Paralysis of the palatal muscles may be the other cause. In the cases of adenoids or where the nasal passage has an obstruction, the voice will lack nasality.

The child who had stumbled with the gander's goosy wanderings had a rhythm disorder. The standard symptoms are stammering and clutterings. Stammering usually begins between 3 and 4 years of age and, surprisingly, is a mainly male phenomenon (maybe not so surprising, if we consider the fact that girls mature faster than boys). Despite several studies, no conclusive reason has been established as far as stuttering goes. In primary stuttering, words, phrases, syllables or the initial sounds of words are repeated without the speaker being aware of it. In secondary stuttering, the repetitions become fixed and prolonged, accompanied by physical and psychological tension and often contortions of face and body. In cluttering, words are slurred and syllables are omitted because of improper phrasing and excessive speed of utterance.

The most serious disorder, however, involves symbolisation — an impairment of language

How a child begins to speak

Age	Behaviour
1-6 months	Cries in response to stimuli
6–8 months	Child is now aware of the sounds he is making and begins to repeat them. Begins to link speech production to hearing
9-12 months	Begins to imitate, with or without understanding, the monosyllabic and bisyllabic words. Responds to "no" and "don't". Front vowels (as in "beet") begin. Back vowels (as in "boot") become more frequent. Earliest consonants used are those formed with both lips
12–18 months	Intentionally employs words in a meaningful way. Picks up conversational jargon
24–30 months	Says small sentences, describes objects and pictures. Comprehends simple questions. Combines words in speech
54 months	Child can produce all the necessary conversational speech with clear articulation.

(The various stages shade off into one another, and vary from child to child. Speech should develop by the second year and is judged to be retarded if there are significant deviations from the norm.)

formulation and expression. The common type is aphasia or dysphasia. It may take the form of difficulty in reading (alexia), difficulty in writing (agraphia), inability to calculate (acalculia) or inability to recognise a symbol (agnosia). The root cause may be a brain lesion.

Aphasia can be of four types : expressive, receptive, amnesic or a combination of these three. In expressive aphasia, the patient cannot express ideas in speech or writing, although there maybe no muscular impairment. Receptive aphasia is the inability to comprehend written or spoken symbols although the sensory organs are undamaged. Amnesic aphasia is the inability to recall appropriate names for different things. In adults, aphasia may be the result of a brain tumour or a brain injury. In children, the cause may be a failure in brain development or brain damage incurred before, during or after birth.

Another symbolisation disorder is delayed speech — from complete absence of vocalisation to vocalisations which have no communicative value. In this case, the major cause may be deafness or damaged hearing or, in some cases, emotional disturbances.

In search of causes

If your child has a speech defect you may have reason to worry. But not every impairment is beyond remedy. Start looking with his physical growth. If the physical growth is delayed, speech too lags behind ; the speech organs are a part of the body, after all. The cause may be prolonged illness in early childhood, neurological disorders, metabolic or nutritional deficiency. Children of slow growth are often labelled as mentally retarded. This is totally wrong. They can be helped by a well-planned speech stimulation programme.

Otherwise, start looking into his mouth — the teeth, palate and tongue. If a child trips up on *s*, *sch*, *ch* and *j* sounds, probably it's the teeth that are at fault. Irregularities in teeth and their wrong alignment may cause overbite or underbite, interfering with normal speech production. A faulty jaw joint can cause cross-bite, interfering with well-articulated speech. The treatment for such cases is orthodontial correction of the teeth and speech therapy, given during or after teeth correction. The palate, of course, is commonly connected with the appreciation of food, but it is even more important in speech production. A common palate defect like cleft palate (with or without cleft palate and lip) may cause poor articulation of consonant sounds like *k*, *kh*, *g*, *gh*, *t*, *d*, *j*, *z*, and *s*, make the voice nasal and hence unintelligible. Dental malformations and/or faulty tongue placement make things worse. The palate's role in speech production could also be impaired by paralysis or paresis, tumours of the nasopharynx and by its shortening after a tonsil operation. Children with cleft palate often have a hearing difficulty which again could impair normal speech development : they should be treated for infection of the middle ear.

The term "tongue-tied" is not just a figure of speech. If you place your finger just below your tongue, you can feel a short membrane (frenum) attaching it to the floor of

How voice is produced

THE ridge-like protuberance in the middle of your throat houses one of the most wonderful structures in the human body — the voice box or larynx, popularly known as the Adam's apple.

It is here that speech sounds begin. Exhaled air from the lungs striking two folds in the voice box makes them vibrate to produce sounds which are shaped into words by movements of the mouth, tongue and lips, aided by the resonating cavities in the skull.

The physical part of speech broadly comprises three processes — respiration, phonation and articulation. These are interacting processes which are activated, coordinated and monitored by the nervous system by acoustical and kinesthetic feedback.

In speaking, we make use of the air exhaled from the lungs. Hence, while speaking, the period of exhalation is longer than that of inhalation. Most of the speech sounds in major languages of the world are formed during exhalation.

The breath stream striking the vocal chords make them vibrate. The loudness of the voice depends on the pressure of air below the larynx. So does accent or the placement of stress ; e g in the word " major ", the accent is on the first syllable and in " majority ", on the second syllable — the difference in stress being achieved by varying the air pressure acting on the vocal chords.

Speech sounds begin in the larynx, which generates what is known as the " glottal tone ". The larynx itself is located at the bottom of the vocal tract, the other end of which is at the lips. The vocal tract is 16 cm long, on an average, in men ; its length may be increased by pursing the lips or lowering the larynx.

The larynx is composed of a group of cartilages, tissues and muscles. The vocal chords are folds of connective tissue and muscle fibres. The vibrating edge of the vocal folds measures 23-27 mm in men, and much less in women. The tension and position of the vocal folds are adjusted by various muscles. During whispering the *glottis* or the aperture between the folds assumes a triangular shape.

" Pitch " of voice depends on the rate of vibration of the vocal folds, which again is related to their tension ; the frequency of vibration increases when the vocal folds are made taut. Many languages make use of differences in the fundamental frequency to distinguish meanings between words ; in Mandarin Chinese the utterance " ma " can mean " mother " or " horse ", depending upon variations in the fundamental frequency.

The formation of words — articulation — involves some muscles of the pharynx, palate, tongue and face, and of mastication. Vowels are produced at the glottis. During vowel production the vocal tract is relatively open and air flows over the centre of the tongue. The humping of the tongue divides the vocal tract into two cavities, the oral cavity in front and the pharyngeal cavity behind. The point of constriction and the tongue height change the relations between the oral and pharyngeal cavities to produce characteristic resonances for different vowels. Try pronouncing the words *height*, *hit* and *hat* in succession and notice the shift in position of the tongue's hump to produce the different vowel sounds.

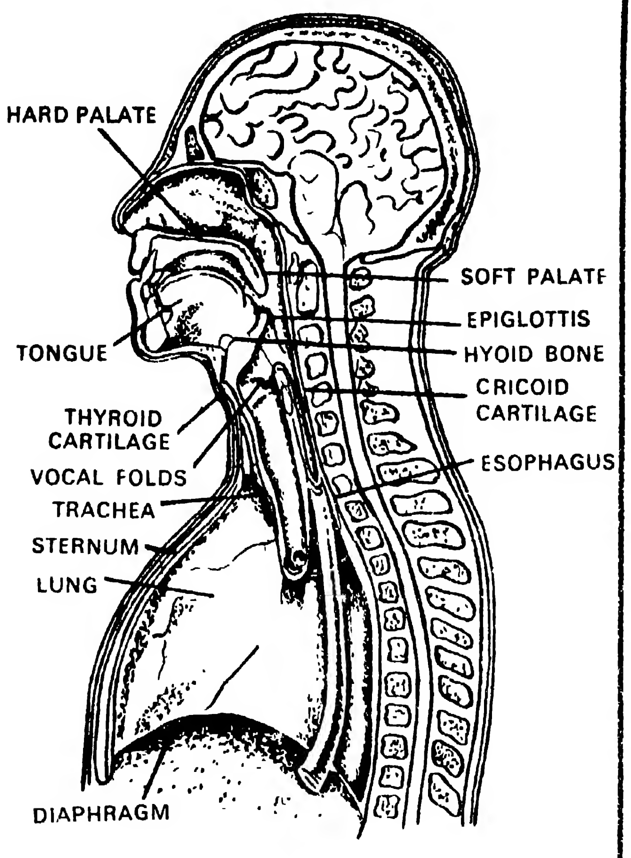
To produce the vowel sounds in words like *bone*, *seen* (called nasalised vowels), the nasal cavities are coupled on to the resonance system of the vocal tract by lowering the velum and permitting air to flow through the nose. To produce a nasal consonant (as in *bend*), the oral passage is completely constricted and air flows only through the nose.

Words like *par*, *bar*, *car* (called ' plosives ') are produced by the complete interception of air flow at one or more places along the vocal tract.

Overall control of speech is by the brain. Three neural pathways are directly concerned with speech production : the pyramidal tract, the extra-pyramidal tract and cerebellar motor pathways. These pathways control the nerves which produce speech nerves which begin in the medulla of the brain and connect with the muscles of the tongue, lips, and larynx. Six of the 12 cranial nerves send motor fibres which activate the muscles involved in speech production.

the mouth. If this membrane is very short, it can restrict the upward movement of the tongue and may be associated with a grooved tongue tip. The affected consonants are *s*, *sh*, *ch*, and *r*. Generally moderate tongue-tie does not interfere with speech development, but a child who articulates poorly and also has a tongue-tie could be helped by releasing the tie surgically.

Normal speech depends on a fine balance and team-work between the voice-producing organs like lips, tongue, soft palate and pharynx. Diseases or accidents which damage the muscles of these structures or their associated nerves or the central nervous system itself may distort the production of individual sounds or their link-up into sentences. Even though words and speech sounds are uttered with care, the



Diaphragm: **Basic driving force for voice production is air pressure produced partly by the rising of diaphragm during exhalation.** ***Lung:*** **Loudness of voice and stress is related to the pressure of air exhaled from lungs.** ***Trachea:*** **Air from the lungs passes to the larynx through the trachea or windpipe.** ***Thyroid cartilage:*** **Provides attachment in front for the vocal chords.** ***Vocal chords:*** **Of primary importance in the production of voice. When the two are brought together and there is balanced air pressure to drive them, they vibrate laterally in opposite directions. Aphasia may result from damage to vocal chords.** ***Tongue:*** **Shape and position of tongue during speech is of great importance in forming speech sounds. Lalling may be caused by poor control of tongue tip.** ***Hard palate:*** **Cleft palate speech is caused by the failure of the bilateral structures of the palate to unite during foetal life**

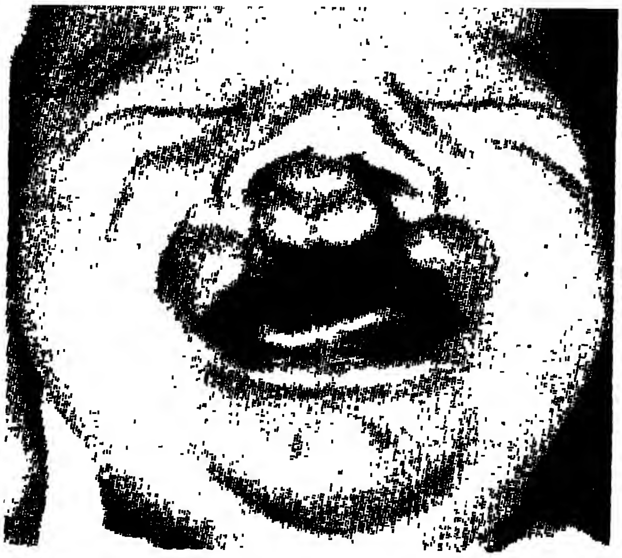
sentences may not have clarity. Children in the age-group 5 to 10, who persist in talking at the top of their voices or scream, often, run the risk of damaging their vocal chords. Fibrous tissues or nodules develop on the vocal chords. Inflammations of the voicebox can cause hoarseness ; growths like laryngeal webs and tumours can produce very shrill and metallic voice. A partially deaf child who talks in a high pitch can also have trouble with his vocal chords.

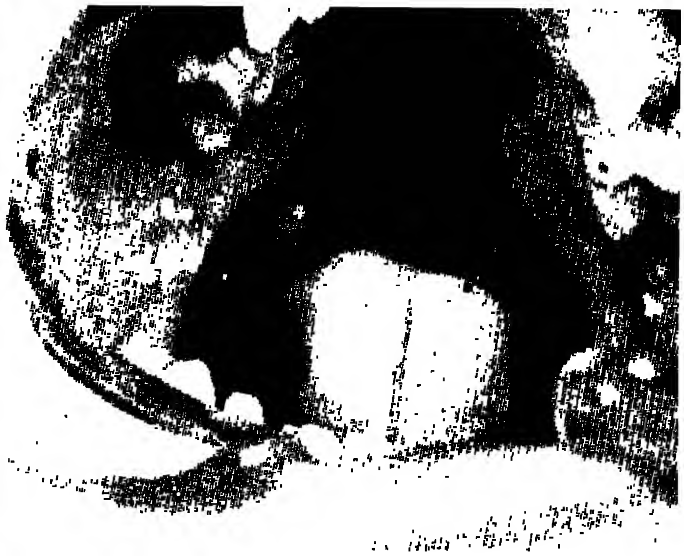
In fact, deafness and speech defect have more than a passing relationship. A child learns to talk by imitating the speech of others and by listening to his own speech. But if he is born deaf, he is deprived of this necessary sensory stimulation. He doesn't get beyond the babbling stage. In such cases it is necessary to identify the hearing loss and cure it if possible. A child with a history of discharging ears, chronic colds or infections of the upper chest should have his hearing checked. The clues to hearing loss can really be taken from the symptoms of speech defect, for instance, defective articulation or poorly inflected voice or high pitch and monotonous voice or poor response to moderately loud sounds. One sure sign is, the child doesn't listen when spoken to and doesn't respond when he is called. Such cases require immediate attention because a suitable hearing aid can help a lot. But, generally, little can be done medically or surgically for severe hearing loss where the nerves are involved. However, conductive hearing loss caused by middle ear infections, frequent coughs and colds, and infected tonsils do respond to medical treatment.

Children who are mentally retarded are also backward in language development. Children of IQ between 80 and 90 develop adequate language provided they don't suffer from other physical or mental shortcomings. When the IQ is less than 70, the child shows noticeable language deficiency, poor speech and tends to repeat things. Borderline cases articulate poorly, and are poor in speaking and writing. Mongols have a typically hoarse voice with or without articulation defects. They may also stutter.

A child's surroundings are closely bound up with his progress in speech and language. He should be free to move about, so that he can be exposed to sufficient stimulation and experience. He should get enough encouragement and motivation for speech, otherwise he may not develop speech within the normal period.

Now for some don'ts. Guard your child from negative influences that might degrade his speech and behaviour. Avoid goading him towards perfection in speech (this holds good for the teacher, too) because it might set up a stress in the child and an unwillingness to speak for fear of committing mistakes.





Above, left: Congenital clefts of the lip and palate in an infant. This defect is worse than the defect of palate alone. But surgery in infancy could avoid future problems. Right: Cleft of the palate. A congenital defect which affects speech very badly. Besides, the patient has difficulty in eating and drinking

What the speech therapist can do

When the speech therapist takes up your child for treatment, he has to know as much as possible about the possible causes — physical, emotional, mental and environmental — of the disorder. Since he will require information about disturbances before or after birth, structural defects, serious illnesses in the past, eye or ear defects, and since only a medical specialist can supply him with such information, it is better to take your child to a physician in the first instance. Children with voice box and hearing troubles should have a thorough check-up of the vocal chords, pharynx and nasopharyngeal region. Those with any brain damage in the form of a stroke, cerebral palsy, degenerative disease, or cranial nerve paralysis should have a check-up by a neurologist. Any disease of the ear, nose or throat should be treated and controlled before the speech therapist comes into the picture.

Similarly, in psychiatric cases, the speech therapist generally has a word with the referring psychiatrist in order to avoid any situation that might excite or depress the patient. If the psychiatric treatment is continuing, he has to report back to the psychiatrist.

If the child's trouble is with articulation, the therapist may prescribe certain tongue exercises or exercises to maintain mouth pressure to pronounce certain sounds like *p*, *b*, *m*, *s*, *ch*, *chh* which require the sudden release of breath. He might prescribe teeth correction if the teeth are so placed that there is no proper 'valve' action for the egress of air. A child with cleft lip and palate can benefit most if his palate and dental structures are set right before the therapist prescribes the exercises for correct palate closure and articulation of speech sounds. Such cases of long-term therapy require maximum cooperation from the parents and the patient.

Similarly, children with voice disorders caused by laryngitis, vocal nodule, fibrosis and tumours should consult an otolaryngologist first. If the vocal chords are operated upon, they might require complete rest before any voice training is started. Often, correct breathing patterns have to be established and ear training has to be given to distinguish between correct and faulty voice.

The speech-defective child is prone to develop faulty habits, inferiority complex and other related emotional disturbances, which make the speech problem more difficult to handle. Stammering or stuttering comes under this category. All of which underlines the importance of going to a speech pathologist early.

Ordinarily, speech therapy extends from six weeks to six months, depending on the severity of the case. The follow-through programme should be continued till the speech therapist decides that no further improvement is possible or that the defect has been overcome.

A speech defect can worsen if handled by unqualified persons. It is, therefore, necessary to seek proper help from qualified therapists. Like medical personnel, qualified speech therapists cannot advertise and hence you may have to seek guidance from your physician.

TECHNOLOGY NEWS

New processes

THE Central Fuel Research Institute has developed and patented a process for making briquettes, incorporating quartzite (silicocoke) from non-coking coal for ferro-silicon and ferro-alloy manufacture. These briquettes, it is claimed, can replace the expensive wood charcoal now being used. Besides, it saves on power, electrode and other costs.

When charcoal or coke is used as charge in ferro-silicon manufacture, there is a considerable loss of power and a high rate of carbon electrode consumption because of the low electrical resistivity of the carbon charged. In the new process, this resistivity is increased by increasing the proportion of the quartzite in the non-coking coal-quartzite mixture used for making the briquettes. The briquettes were made in a 10-tonne hydraulic press using a plunger-type cylindrical mould, cured by heat-hardening in a curing furnace and then carbonised in an electric tube furnace. Briquettes with 15 per cent quartzite had a resistivity of 0·25 ohm/cm, while metallurgical coke heated to 1,200°C had a resistivity of only 0·14 ohm/cm.

Here are some more indigenous products and processes developed by the national laboratories. Licences for the processes can be obtained through the National Research Development Corporation of India, New Delhi-24.

A process for the manufacture of semi-conductor testing equipment used in the manufacture of semi-conductor devices such as transistors, diodes and integrated circuits, etc, based on metal sheets and semi-mica sheets, has been developed by the Central Electronics Engineering Research Institute, Pilani.

A process developed by the Central Food Technological Research Institute for the removal of aflatoxin in food materials is claimed to render groundnut products safe for consumption. It removes the nutty odour and gives the product an attractive colour. However, the process requires a minimum investment of Rs. 1 lakh and also boiler facilities.

The National Aeronautical Laboratory, Bangalore, has developed a device for measuring strain in structures, machines, etc. A plant capable of producing 50 units a year is estimated to cost Rs. 76,000.

A water-proofing solution, hydrobar-C, developed by the Central Leather Research Institute, Madras, is claimed to make cutsoles more moisture-resistant. The demand for the product is estimated at 100 tonnes a year and all the raw materials required are available indigenously. The Institute has also developed a cheap process for the scouring, bleaching, dyeing, softening and straightening of bristles, a mud thinner for deep drilling as a substitute for imported products like LS-33, CL-20, horse-tail hair used in the violin bow and a glazing lacquer.

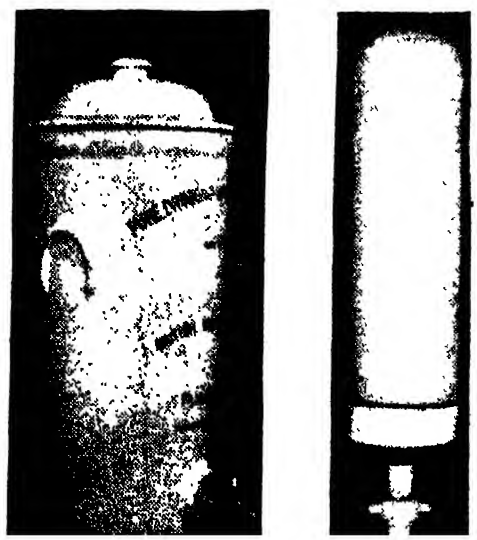
Ceramic water filter candles

CERAMIC water filter candles are used to clear drinking water of suspended impurities and waterborne bacteria such as those of cholera, dysentery, typhoid, etc. Where scarcity of drinking water or pollution causes health hazards, the filters can be of great help. These candles, now imported under the trade name 'Berkfeld', are made from kieselguhr, a special type of cellular silica the right quality of which is not available in the country. About one lakh such candles are imported annually involving a foreign exchange of Rs. 10 to 16 lakhs.

The Central Glass and Ceramic Research Institute, Calcutta, has developed a process for making such ceramic filter candles using common indigenous ceramic materials. The product has been tested by the Indian Institute of Hygiene and Public Health, Calcutta, and the Central Public Health Engineering Research Institute, Nagpur, and other organisations and found satisfactory, claims the Institute.

The manufacturing cost is about Rs. 5 per candle. An imported candle costs about Rs. 15

Left: Imported Berkfeld-type filter. Right: CGCRI-made filter



to make; the market price ranges from Rs. 40 to Rs. 90.

The Institute has also developed Katadyn-type candles used by the army in Katadyn pocket water filter pumps. Imports of these candles now cost Rs. 14 lakhs annually in foreign exchange.

Chemicals dominate

What are the main trends in world industry? Chemicals — petroleum, coal, rubber and plastic products — are the fastest growing industry in the world, according to a United Nations report. In the 15 years since 1969, the world chemicals production rose by 9·4 per cent annually. Coal mining had the poorest growth record, the output rising by only 0·9 per cent a year.

Electricity, gas and steam production had the second best growth rate. Energy production from these sources increased by 8·6 per cent a year. Other areas with high annual growth rates are metal products (7·8 per cent), non-metallic construction materials (7·5 per cent), heavy manufacturing (7·6 per cent) and textiles (4·3) per cent.

However, if the analysis is limited to developing countries, crude petroleum and natural gas production top the industrial sector with a 10·7 per cent growth rate. An important trend is that coal mining declined by 1·3 per cent annually in the developed countries while it rose by 5·1 per cent in the developing countries. The study is included in *Growth of World Industry, 1969*, published by the UN Statistical Office.

SALVAGING FROM WASTE

Iron Powder from Millscale

MILLSCALE formed in industrial operations is a wasteful product. Large quantities of iron millscale are thrown away as waste in India, particularly by sheet rolling, wire and rod-drawing industries. Why not use this millscale to regenerate iron powder for industrial uses? This is what the Central Electro-Chemical Research Institute, Karaikudi, has done. And the process it has developed has been patented. The CECRI claims that the regenerated iron powder can be used for the manufacture of welding electrodes, sintered metal parts and certain chemicals. Iron powder is now being imported.

The CECRI process involves the cathodic reduction of finely powdered millscale in the solid phase; the millscale powder is kept as a sediment over a suitable cathode material in an alkali medium and a direct current is passed. The iron powder thus produced is washed free of the alkali, stabilised and annealed in hydrogen or cracked ammonia at a high temperature. The final product is claimed to compare favourably with the imported varieties.

The operation is economical even on a small scale. The cost of the iron powder is estimated at Rs. 3,400 per tonne for a smallscale production capacity of 500 kg a day. Besides, all the plant and machinery needed are available indigenously.

Potassium Fertilisers from the Sea

POTASSIUM fertilisers are valuable plant nutrients in modern agriculture. These fertilisers include potassium sulphate, potassium chloride, potassium schoenite, etc. Because of the lack of potash deposits in the country, India imports potassium sulphate. But the demand for potassium fertilisers is growing.

To meet this demand, the Central Salt and Marine Chemicals Research Institute, Bhavnagar, Gujarat, has developed a process for the manufacture of potassium chloride and potassium schoenite from mixed salt from the sea. The schoenite could be then converted to richer nitrogen-potassium fertiliser by making it react with ammonium carbonate. The process also yields a useful byproduct — light basic magnesium carbonate.

The first plant has been set up in the private sector in Kandla, Gujarat, with a capacity of 1,000 tonnes of potassium chloride and 2,000 tonnes of potassium schoenite. Another 10-tonne plant has been set up in Tuticorin, Tamil Nadu. A third will soon come up in Gujarat. It is estimated that the country has a potential for an annual production of one lakh tonnes. This would mean a saving of Rs. 2 crores in foreign exchange.

SUPERCONDUCTIVITY

K. N. JOHRY

IN 1908, the Dutch physicist, Hilke Kamerlingh Onnes, succeeded in liquefying helium from its gaseous state. By its use he was able to get temperatures as low as 1°K (0°K or Kelvin is the measure of absolute temperature equal to –273°C). One of the first investigations Onnes carried out with the newly acquired low-temperature range was a study of the electrical properties of metals at varying temperatures. In 1911, he found that when mercury was cooled to the boiling point of helium it lost all its electrical resistance. This, in itself, was not unexpected. What was surprising, however, was that the fall in resistance was not a gradual one as temperature was lowered but was sudden when the temperature reached about 4°K. Later, Onnes found that this phenomenon was restricted not just to pure metals but to impure ones as well. He named the phenomenon superconductivity.

In theory, therefore, superconductors should carry any current for an indefinite period of time. To test this Onnes induced a current in a ring of superconducting metal. Several hours later, he measured the magnitude of the current by means of the magnetic field it induced. The current had remained unchanged. Subsequent investigations by others showed that superconductors could carry currents for much longer periods of time.

Since then, over 900 different superconductors have been discovered. These include metals, alloys and chemical compounds. For many years it was thought that all superconductors behaved in a basically similar pattern. But now it has been found that there are broadly two types of superconductors — the Type I (those which become diamagnetic abruptly) and the Type II (whose diamagnetism flexes over a range). Most elements are Type I superconductors whereas alloys are Type II (see box on p. 48). These categories were influenced not so much by the electrical properties of the various superconductors but by the magnetic properties they acquired when they reached the superconducting state; all superconductors became strongly diamagnetic. It was later found that these properties were acquired when a change occurred in the motion of conducting electrons in the material (see box on p. 44).

The technological possibilities of such superconducting materials are almost infinite. Scientists could foresee superconducting transmission lines and cables that could carry large currents without wasting power to overcome electrical resistance; coils and windings of generators, motors and transformers that could create intense magnetic field without generating large amounts of heat; small and compact electrical equipment that could improve efficiency and economy — especially in air and rail transport; amplifiers; particle accelerators; and newer, more sophisticated computers.

But there are drawbacks to the use of superconductors. The main one is the very low temperatures associated with the phenomenon. The refrigeration equipment to maintain these materials at such temperatures is complex and bulky. Also, such projects are economically unfeasible. Scientists are, therefore, investigating the possibility of obtaining metals or alloys that enter the superconducting state at higher temperatures. The highest critical temperature—above which the metal reverts to normal—achieved till now was about 20·7°K. This was for an alloy of niobium, aluminium and germanium developed in the US. Superconductivity at room temperature appears to be an unlikely achievement. The more modest target is to obtain stable superconductors in the liquid hydrogen region (above 20°K). It has taken nearly ten years of research to lift the temperature from 18 to 20°K and it would be rash to be too optimistic about obtaining superconductors in the 25 to 30°K range in the near future. Even in the 18 to 20°K range, the temperatures are far below the range of simple refrigeration systems.

In addition to the low transition temperatures, there were other reasons why super-

conductors could not make much headway for over 60 years. One was the reaction of superconductors to magnetic fields. Just as superconductors revert to normal once they pass a certain critical temperature, so also they do not remain in the superconducting state when they are subjected to a certain critical magnetic field. The highest critical field for the elemental Type I superconductors is about 2,000 gauss at near 0°K. That meant such superconductors could not be used for electrical machines. But again, newer alloys that can withstand strong magnetic fields without reverting to normal have been discovered. They include the intermetallic alloys based on the metal niobium, like niobium-tin, niobium-titanium and niobium-zirconium. And superconductors also lose their superconductivity if they are subjected to a critical current. This critical current varies with the critical temperature.

Most metals contain certain impurities. This has an effect on their superconducting properties. Even when a pure metal is used, there may be poor contacts or mechanical damage in the superconducting winding. This gives rise to a problem that again makes it difficult to use superconductors efficiently. The problem arises from the sudden jumps in magnetic flux that occur because of such defects. These defective pockets in the metal cause erratic movements in the magnetic flux and revert these pockets to normal. Also, with flux jumps the temperature rises. Consequent to the rise in temperature comes the loss of superconductivity and magnetic field as the cooling system is often inadequate in preventing the temperature exceeding a critical value for the prevailing current and field conditions. The problem has been solved with the introduction of copper-plating on the surface of superconductors. The copper sheet absorbs the local heat and acts as a bypass for current over the affected areas.

The next stage was the development of composite superconductors. These were in demand for use in larger magnets. The first such composite superconductor comprised a number of copper-plated wires twisted together with insulation and laid around the bundle. Later, the wires were impregnated with metals like indium and cadmium. By using a suitable type and quality of normal metal in composites, fully stabilised superconductors have been produced in which the adverse effects of flux jumps are eliminated. The current is thus carried indefinitely in the non-superconducting material without any raising of the temperature of the

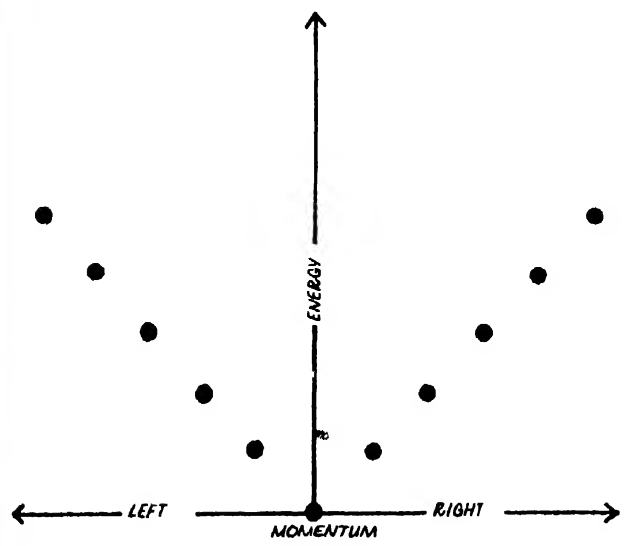
Continued on page 47)

It was only in 1957 that a comprehensive theory of superconductivity was developed by J. Bardeen, L. N. Cooper and J. R. Schrieffer. The Bardeen-Cooper-Schrieffer (BCS) theory is a long and complicated one as it deals with an astronomically large number of electrons in a highly cooperative state.

All metals are composed of atoms. These atoms are, of course, composed of a nucleus, which contains the protons and neutrons, and electrons moving around it in different orbits, in the way the planets orbit round the Sun. The electrons in the outermost orbits are not very strongly attracted to the nucleus and often break away from the atom and roam about freely in the metal. But they are not completely free. There are certain physical laws that restrict their movements. The first is a quantum mechanical restriction. Quantum mechanics permits only certain energy states or velocities for electrons. Electrons are arranged in these energy states. But here there is another restriction arising from the Pauli Exclusion Principle — that only one electron at a time can be in any one of the permitted energy states or velocities. Within these two limits, free electrons can arrange themselves in any way in the metal. Normally, the most stable energy form (ie the most stable arrangement of electrons) is when all the electrons occupy the low energy states.

Electrons can either move to the right or to the left in a metal. For every electron that moves to the right there is an opposite one in the same energy state moving to the left. And in the most stable form there are as many electrons moving to the right as to the left. When such an equilibrium of electrons is maintained in a metal, no current can flow through it. In this state, the average velocity in either direction is zero.

What happens if a current is induced in a metal? Firstly, the current disrupts the equilibrium of electrons in the stable state. All the



What is superconductivity?

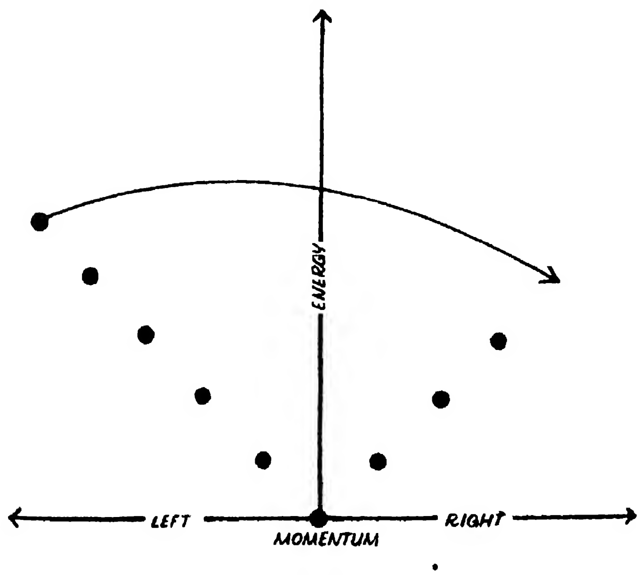
electrons are forced to move in one direction. They are given a drift velocity. That means if the current flows to the right, the velocities of the electrons already moving right will be increased. The velocities of the electrons that were originally moving left will naturally be decreased. Thus the electrons originally moving right will experience an energy gain while those originally moving left will lose energy. The average energy of the whole system will now be slightly higher than the energy of the equilibrium state as the drifting electrons impart additional kinetic energy to the system. Unless some external force is applied, this asymmetric distribution will not last as the electrons will soon revert to the most stable form. The current will soon stop as electrons moving right collide with imperfections like impurities and physical defects in the metal and get knocked back to the lower energy states moving to the left. Eventually, the original balance will be attained.

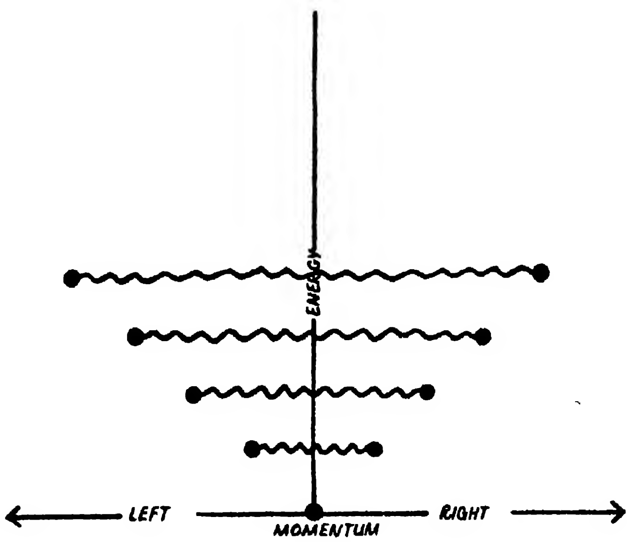
Now we come to superconductors. In superconductors electrons do not move singly but in pairs. As electrons are paired, their movement is restricted. This restriction occurs because one of the requirements of pairing is that the momentum of the centre of mass of each pair should be the same as that of the majority of the other pairs. It is difficult to break up pairs in a superconductor. It takes a certain energy to break up a pair. This energy can be provided by a violent collision of the pair with an imperfection in the metal. The kinetic energy of the collision should be greater than the energy that holds the pair together. Once a pair breaks up, the two electrons of the pair are left without mates. They cannot pair up again because their respective centres of mass would have the wrong momentum.

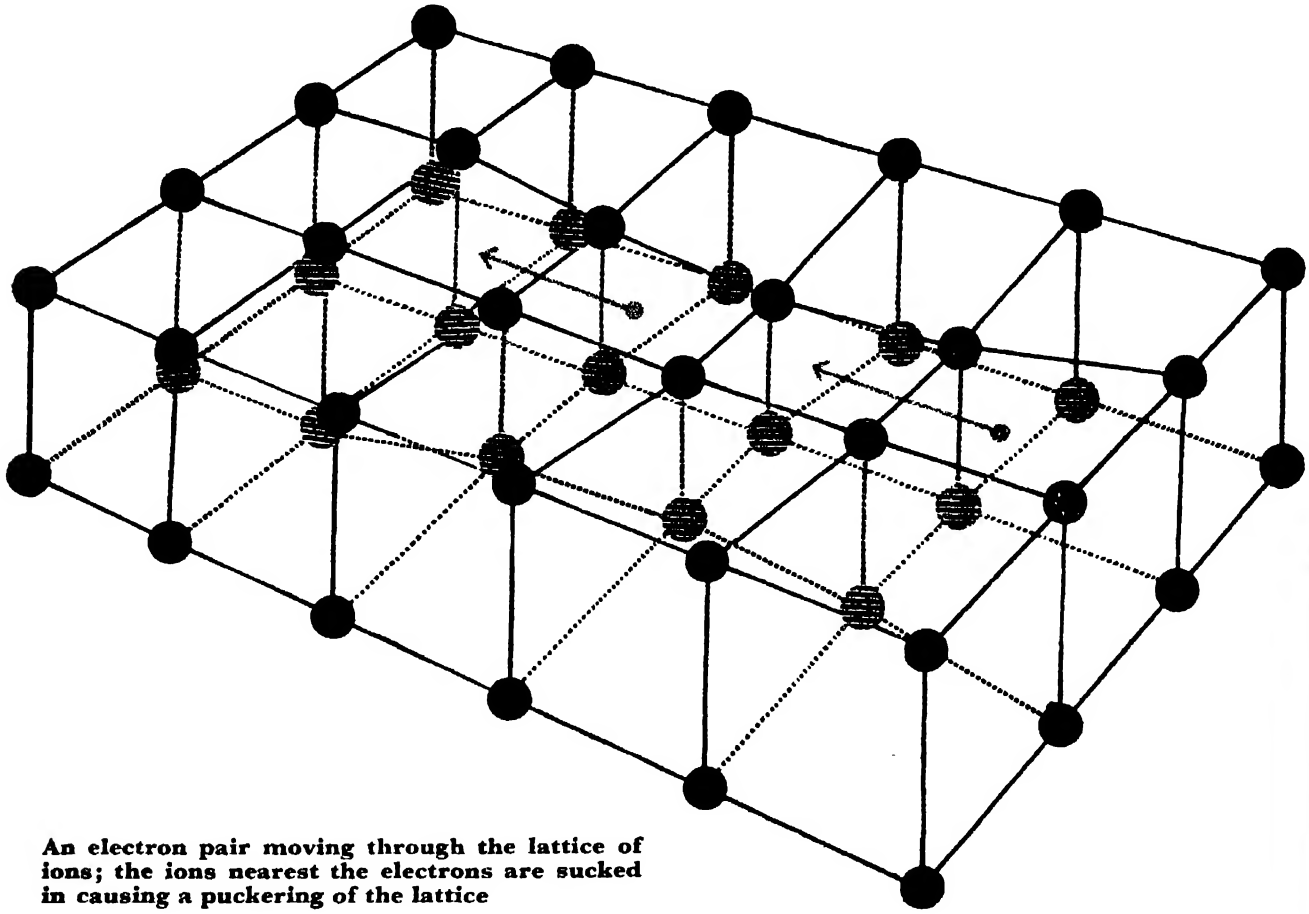
But why should electrons pair in a superconductor? Electrons are negatively charged particles and it is known that two negatively charged particles always repel each other. This can be explained if we look at the structure of atoms in a metal. Atoms in a metal form a lattice framework (like hundreds of cubes stacked together with atoms forming the corners of the cubes). When these atoms loose electrons from their orbits, they become ions with a positive charge. These ions attract the negatively charged free electrons. When a free electron moves near an ion, the attraction causes the ions nearest to it to move in slightly. This movement causes a distortion in the lattice framework — a sucking in. At the point where the ions are sucked in there will naturally be an excess of positive charge (because of the higher density of ions in the region). This excess of positive charge now attracts the next free electron. If the indirect attraction of the ions for the second electron is greater than the repulsive forces between the first and second electrons, these two electrons get paired. This pairing occurs at very low temperatures. At higher temperatures, the thermal agitation of the electrons prevent pairing or disrupt any pairs that might exist.

The attractive or repulsive forces of an electron extend for only a short distance, i e its range of

Electrons tend to occupy the lower energy states, leaving the higher states empty. For each electron moving right, there is one in the same energy state moving left (far, left). Electrons in higher energy states tend to fall into the lower energy states (centre). At right are paired electrons







An electron pair moving through the lattice of ions; the ions nearest the electrons are sucked in causing a puckering of the lattice

interaction is short. Therefore, as it comes near the ions it gives a short, sharp tug and moves on. The ions move slower than the electron. By the time they reach their maximum range to come as near to the electron as possible (this range is governed by the elastic restraints of an ion's neighbours), the electron would have moved on. That means the movement of electrons and ions do not coincide. The ion movement follows after the electron movement thus enabling the next electron to follow at a safe distance.

But there is one problem. Other electrons could also experience the attraction of the ions and move in between the paired electrons as there is enough space between the two. The result would be chaos, with a mass of uncorrelated electrons butting in and disrupting the pair. To avoid such a situation, all the electrons should have a correlated motion (ie all should move at the same velocity in the same direction) so that they do not interfere with each other and enable pairs to coexist. That means all the pairs in a superconductor should have the same centres of mass. This is exactly what happens at low temperatures (near 0° K). At such temperatures the loss of freedom of individual electrons is compensated for by the gains in energy of pairing. At higher temperatures, as mentioned earlier, thermal agitation breaks up pairs. The electrons from broken pairs disrupt other pairs. At a certain critical temperature the break up becomes catastrophic and the metal reverts to normal.

We have mentioned earlier that the movement of ions in the lattice framework is restricted by the elastic restraints of its neighbours. When an ion stops at its limit (ie its maximum range), its kinetic energy is converted to potential energy. The displacement of an ion (ie the distance over which it travels to its maximum range) has been mathematically shown to be inversely proportional to the square root of its mass. Thus the heavier the ion is, the less it is displaced. The larger the displacement, the greater is the positive charge in the region through which the first electron has passed. Since the second electron is attracted by this positive charge and since this attraction binds it to the first electron, the strength of the pairing would thus be dependent on the mass of the ions in the lattice framework. The temperature needed to break up pairs would depend on the energy of the pairs. As the energy of the pairs depends on the mass of ions, the transition temperature would thus, in turn, be inversely proportional to the square root of the mass of ions.

(Continued from page 44)
composite above the critical temperature of the superconductor.

If a superconducting device is to be a practical proposition, the gains from the savings in electrical power should more than offset the disadvantages — mainly the cost and bulkiness of the associated refrigeration equipment. One area in which these criteria apply is where large volume and strong magnetic fields are needed, for instance, bubble chamber magnets, magnets for containing plasma, the magneto-hydrodynamic generation of electricity, and the static fields of various large motors and generators.

Most high energy nuclear physics laboratories have huge conventional electromagnets feeding on an enormous supply of electricity. For example, the one at the National Magnet Laboratory at Cambridge, Massachussetts, USA, generates continuous fields as high as 200,000 gauss. But the electrical power consumed by the magnet — an estimated 16 million watts — is large enough to meet the power requirements of a town of 15,000 inhabitants. With such high power consumption, there is consequently a large amount of heat generated in the coils through electrical resistance. To cool the coils involves the use of large amounts of water.

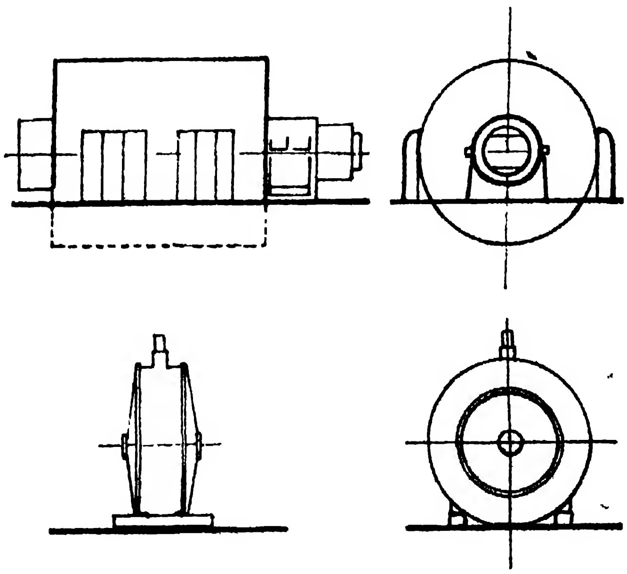
There are, however, magnets that produce high fields without consuming any power. These are the permanent iron magnets. But here the highest field produced to date is in the vicinity of 10,000 gauss. Superconducting magnets, therefore, promise, among other things, much higher fields without any power consumption. Since superconducting magnets have no current-carrying coils there is no heat dissipation. Strong fields can thus be maintained without any expenditure on power. That means the operating costs of a superconducting magnet are a mere fraction of those of conventional systems; the only power expense is involved in establishing the field initially and in keeping the temperature of the coils well within the superconducting range.

As superconducting magnets are compact, they are capable of producing much steeper field gradients than conventional magnets. This feature is especially important as the distance between the regions of high and low fields is small and auxiliary apparatus that might be sensitive to magnetic fields can remain unaffected.

Type I superconductors (page 48) are unsuitable for use in high-field superconducting magnets as they have a critical field of only about 1,000 gauss. Once they are placed in higher fields, the magnetic flux penetrates the material and destroys superconductivity. However, Type II superconductors, especially certain alloys, can retain their superconductivity in very high fields. In fact, it is believed that there may be superconductors with upper critical fields as high as 300,000 gauss.

The world's largest 'super magnet' is the 20,000 gauss superconducting magnet set up for the bubble chamber at the Argonne National Laboratory. It is estimated to have cost a crore of rupees which is almost 25 per cent less than the cost of a huge conventional electromagnet. But it is in the recurring costs that the main advantage lies. At Argonne, these costs are a mere tenth of the costs of running a conventional electromagnet. And these are the costs of refrigeration. That means an annual saving of about Rs. 75 lakhs. This superconducting magnet consumes 25 KW of refrigeration power to remove the 50 watts or so dissipated by the coils and to keep the windings at the temperature of liquefied helium. In comparison, a conventional electromagnet of the same size and performance would need 11 MW of electrical power. In fact, superconducting magnets are such highly attractive economic propositions for research purposes that several large bubble chamber magnets of this type are being designed around the world, including a 70,000 gauss superconducting magnet at the Rutherford Laboratory, England.

Comparative size of the conventional motor (above) and the superconducting motor (below). Both are 8,000 hp, 50 rpm



The way superconductors behave

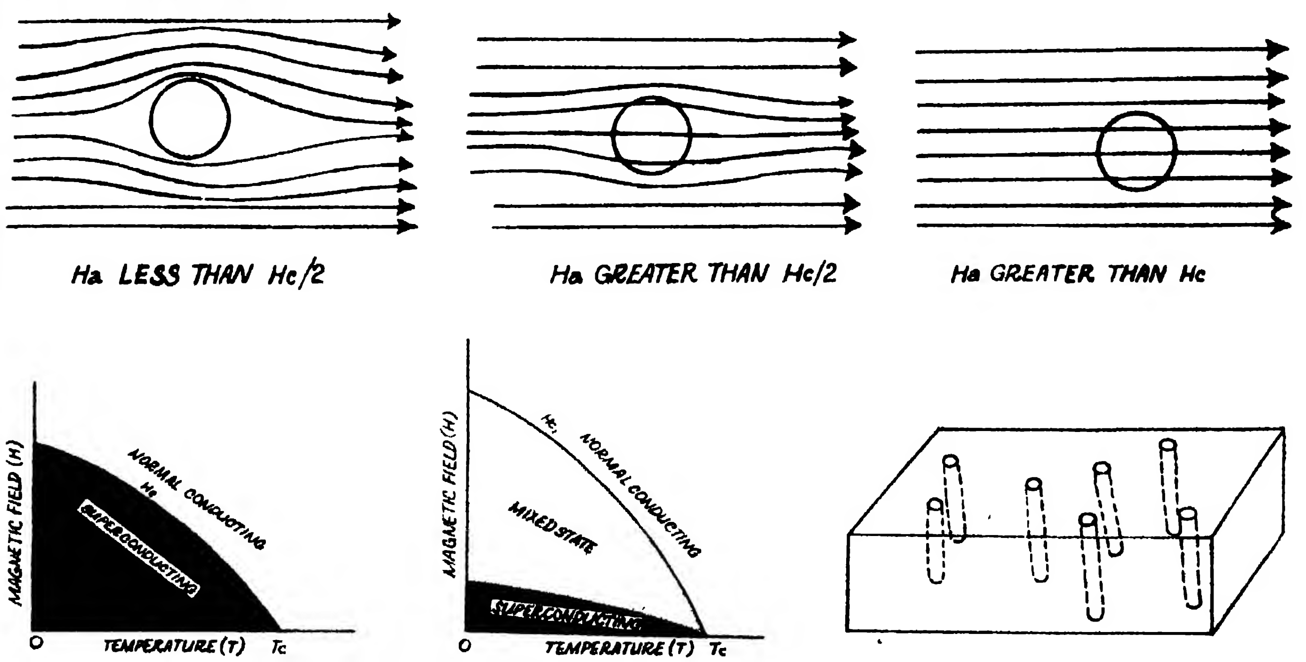
Most metallic elements can be superconductors. But alkali metals, alkaline earths, elements in the same column of the periodic table (nickel and copper), ferromagnetic elements and antiferromagnetic elements are not superconductors. Or rather they might become superconductors only at sufficiently low temperatures. Till now they have been tested to only 0·1°K. These elements can, however, be components of superconducting compounds.

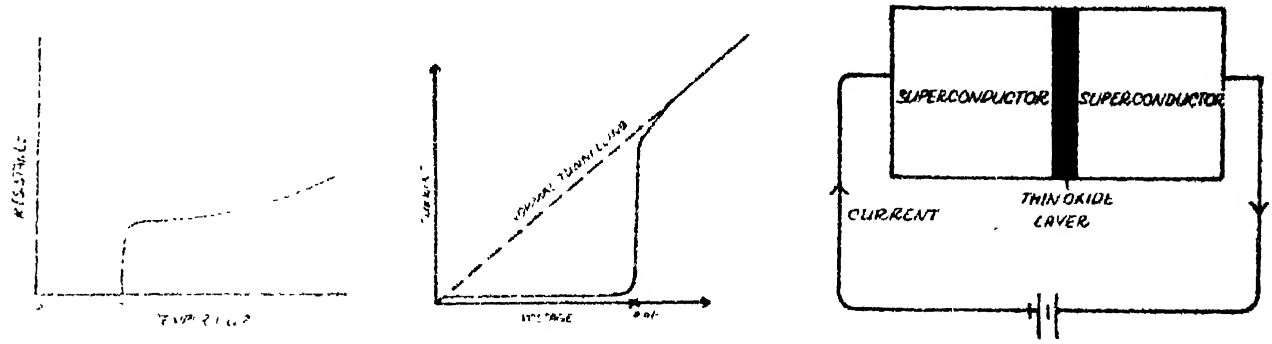
There are two main factors that influence the transition of any material from the normal to the superconducting state — the temperature and the magnetic field surrounding the material. Once the material falls below a certain critical value of temperature (Tc), and if it is in a magnetic field below a certain critical value (Hc), it becomes a superconductor. But not all superconductors react to changes in temperature and magnetic field in the same way. The elemental Type I superconductors experience an abrupt change from normal magnetic permeability to diamagnetism when they enter the superconducting stage. The Type II superconductors, the alloys and materials with physical defects that shorten the mean free path of electrons, however, do not become diamagnetic with such abruptness. They first lose their electrical resistance but retain their full magnetic permeability at an upper critical magnetic field (Hc_2). Gradually, at a lower critical field (Hc_1), their magnetic permeability too becomes zero.

The first important quality of superconductors is their zero resistance. Once the material falls below its transition or critical temperature, it loses all its electrical resistance. The fall is sudden and abrupt; for a 0·001° K temperature interval, the resistance falls by a factor of about 10^{11} to 10^{20} ohm-cm. That means, if a current is induced in a superconducting ring, it will flow for an indefinite period of time since it encounters no resistance.

Superconductors are diamagnetic. The German physicists W. Meissner and R. Ochsenfeld discovered this in 1933. This meant that superconductors completely exclude any external magnetic field. They found the magnetic field distribution changed when the temperature was lowered. This was a puzzling aspect of superconductors as the perfect conductor has no electromotive forces. If there are no electromotive forces it means there is a constant interior and, hence, exterior magnetic field. But this is not the case in superconductors. The explanation for this

(Below) A magnetic field is excluded if the field strength is less than half the critical value in Type I superconductors. When the field is greater than half the critical value, parallel lamellae of magnetism pierce the superconductor. When the strength exceeds the critical value the field penetrates fully and destroys superconductivity. (Bottom, left) The relationship between magnetic field and temperature in Type I superconductors. (Bottom, centre) The relationship between magnetic field and temperature in Type II superconductors. There is an upper (Hc_1) and lower (Hc_2) critical magnetic field. The intermediate between the two is a mixed state superconductor. (Bottom, right) Magnetic field penetrates Type II superconductors in minimal core bundles





(Left) The relationship between temperature and resistance. When the temperature reaches a critical value (Tc), the resistance drops suddenly and the material becomes superconducting. (Centre) The tunnelling effect. At a certain voltage value (2△/e), the current rises steeply. (Right) Two superconductors divided by a thin oxide layer for tunnelling

is that the material is in thermodynamic equilibrium at each temperature. To maintain a superconducting equilibrium, the material has to reduce its magnetic induction. It does this by expelling all or part of the magnetic flux within it, thus becoming diamagnetic. A magnetic field less than the critical field in Type I superconductors and below the lower critical field in Type II superconductors penetrates a very small distance into the material. It falls to a third of its value at a distance of approximately a hundred-thousandth of a centimetre below the surface. The interior magnetic flux is expelled by surface currents in the material. These surface currents screen the interior by contributing their own magnetism that cancels the magnetic field inside. These currents flow in a veiy thin layer of the surface.

Because it expels flux, a superconductor distorts any magnetic field it is placed in. This distortion depends on the shape of the superconductor and the way in which it is placed in a field. If a long, cylindrical superconductor is placed parallel with the lines of force in a magnetic field, it has very little effect on the field at points outside the rod. But if the rod is placed perpendicular to the field and if the field is not strong enough to destroy superconductivity, the effects can vary between the types of superconductors. For the Type I superconductors, there is an intermediate stage before a magnetic field can be strong enough to destroy superconductivity. At applied field strengths above the critical field, magnetic flux starts to penetrate the superconductor through nonsuperconducting lamellae that run parallel to the applied field. The lamellae are evenly spaced. As the field strength increases, the distance between successive lamellae decreases — that is the superconducting fraction decreases — till at the critical field they disappear and the superconductor reverts to normal.

In Type II superconductors, placed transversely in a magnetic field, the flux begins to penetrate as soon as the field strength goes above half the lower critical field. The flux does not penetrate in lamellae but in bundles. Each bundle is centred around a nonsuperconducting core and the flux intensity drops off in all directions from this core. The bundles are kept to the minimum size permitted by a quantum condition. When the applied field reaches the upper critical value, the bundle cores merge and superconductivity is destroyed. Superconductors of Type II are in their mixed state when they are pierced by such minimal flux bundles.

If a pure superconductor is placed in a strong magnetic field and if the field is gradually decreased, the magnetic condition of the superconductor will follow a reverse order to the course it takes in an increasing field. But as there are always inhomogeneities in materials, in actuality there are remnants of locked-in flux even when the magnetic field is completely withdrawn.

If two identical superconductors are separated by a thin oxide layer, and even if there is no potential difference between the two supeiconductors, pairs of electrons will tunnel though the oxide layer, provided it is thin enough, from one superconductor to the other. If there is a small voltage difference between the two superconductors, almost no current will flow. When the applied voltage reaches the magnitude 2△/e, the electron pairs split up. (2△ is the energy gap and e is the electronic charge. The energy gap is the difference between the minimum energy for disruptive addition and cooperative addition. Two electrons can be added to any of the cooperative states in a superconducting system in such a way that the degree of cooperation remains unchanged. This addition requires the same energy that would be needed for addition to a normal state of the same material. If they are added in any other way they have a disrupting effect.) When the voltage increases past 2△/e the tunnelling becomes suddenly rapid. The increased current is large for a small increase in voltage at this point. This makes such superconducting devices useful in amplifying systems and as memory devices for computers.

It was only after World War II that any serious investigations were carried out on superconducting machines. The International Research and Development Co Ltd at New Castle, UK, was the first to consider the possibility of superconductors in a dc electric machine. For superconducting machines, it is essential to have a stationary field system. Moving field systems with rotating armatures cannot easily operate at cryogenic temperatures. Besides, armature reactions would subject an already unstable superconductor to time-varying magnetic fields. Torque reactions involve mounting the superconductor on strong supports. These supports would inevitably conduct heat to the refrigeration system, thus increasing the size of the refrigerating equipment.

But there is a machine that does not have the problems of armature reaction and torque reaction. This is the homopolar machine. The homopolar motor-design is based on a Faraday disc — a disc of conductive material named after the inventor of the homopolar principle, which is capable of rotating in a magnetic field which cuts the disc at right angles. If the current is passed through the disc in a radial direction — in at the shaft and out at the rim or vice versa — a torque is produced; as the disc speeds up, power is developed. The first motor designed at IRD had a superconducting winding to provide a high magnetic field through the bore which contained the Faraday disc equipped with slip rings at inner and outer radii. This IRD superconducting motor developed 50 hp at 2,000 rpm when it was operated. It confirmed the feasibility of the new idea and it helped IRD to launch work on their much larger motor with an output of 3,250 hp at 200 rpm. The new motor has since been installed and successfully tested in driving and cooling water pumps at the Central Electricity Generating Board's power station at Fawley near Southampton. The winding of this motor contains over 5 tonnes of stabilised superconductors made from a composite of niobium-titanium alloy and copper.

The homopolar motor is particularly appropriate for applications requiring very high torque at low speeds. The team is investigating some of these applications. It has completed a study with the British Ship Research Association on the feasibility of putting a 4,000 hp supercold generator-motor combination in the British Rail Channel Ferry. Superconducting homopolar machines can also be designed to serve as dc generators providing large electrical outputs at relatively low voltage. IRD is presently working on a one megawatt generator. These generators would be particularly useful in the electrochemical industry.

One of the brightest long-term hopes for superconductors lies in power transmission. The possible use of superconductors in underground cables is being studied. Links of this kind may be justified where very large quantities of power have to be transmitted. A break-even point in cost, compared with conventional underground cables, it has been suggested, might be found where loads of 1,000 to 2,000 megawatts have to be supplied. But although superconductors will pass direct current without dissipation of power, they have the curious property of exhibiting losses when carrying alternating current. Since many of the applications envisaged, such as motors, generators and transformers, would need alternating current, these losses must be minimised. Present investigations involve studying the reaction of superconducting materials to alternating currents and fields. A number of possible methods of reducing the loss have emerged, including increasing the surface smoothness of the conductor, and cladding the superconductors with copper. A further possibility lies in reducing the physical dimensions of the conductor to the level of a few microns.

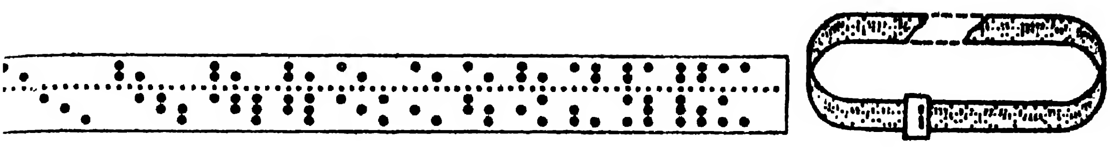
Of course, since superconductivity involves very low temperatures, superconductors are useful in cryogenic devices. Cryogenic systems have advantages over ordinary systems operating at room temperature. They have low power dissipation and high speed operation, they have a high reliability, they cost relatively less, there is no circuit noise and their construction is simple. Moreover, the various tunnelling effects (page 49) between two identical superconductors make them especially useful in amplifying devices and, more important, as electronic memory devices for a newer generation of computers.

In the years to come, investigations to raise the transition temperature will go on. Larger superconducting solenoid magnets will someday be used for confining plasmas in fusion reactors. Large superconducting motors and generators will be in competition with conventional units. The Japanese National Railway is already developing a train levitated with superconducting motors. Hovercrafts of the future can fly on a roadway of superconducting sheets. The possibilities are, as it has been said earlier, infinite.

James Bond had a knack of putting his head into the lion's mouth and of getting entangled with sex-kittens. The 007s of today avoid such occupational hazards by employing a wide range of electronic gadgets

THE SCIENTIFIC ART OF SPYING

PRAVIN KUMAR



One-time tape. Message tape *(left)* is perforated like standard teletypewriter tape. Key tape *(right)* is perforated at random

YOUR business is my business, sang Maurice Chevalier in one of his musicals. This view of privacy is dittoed by the major nations which nowadays employ a formidable array of equipment and men in ferreting out one another's secrets. Though espionage is as old as diplomacy and power politics, what is new about the latterday cloak-and-dagger game is its technological content. The James Bond type of intelligence man is about as obsolete as Sherlock Holmes. He has been replaced by teams of square-jawed, nondescript, unheroic men sitting in drab buildings and plugging away at sophisticated cypher machines; by trawlers carrying ultrasensitive listening devices; and by reconnaissance satellites that can read the names on lorries 320 km below on earth.

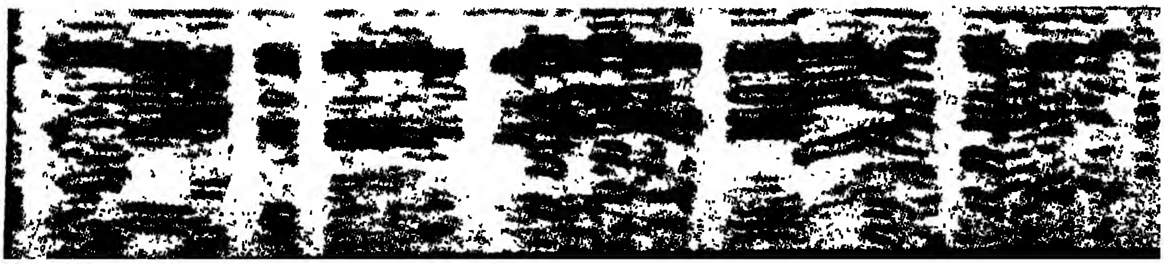
Intelligence activities go on all the time. Perhaps they have a utility, albeit a dubious one, in ensuring that no one nation enjoys a marked advantage for very long. Occasionally, the snooping game hits the headlines, as in 1968 when the American spy ship *Pueblo* was captured by the North Koreans. As recently as September last year, Britain expelled 105 Soviet diplomats suspected to be active KGB agents.

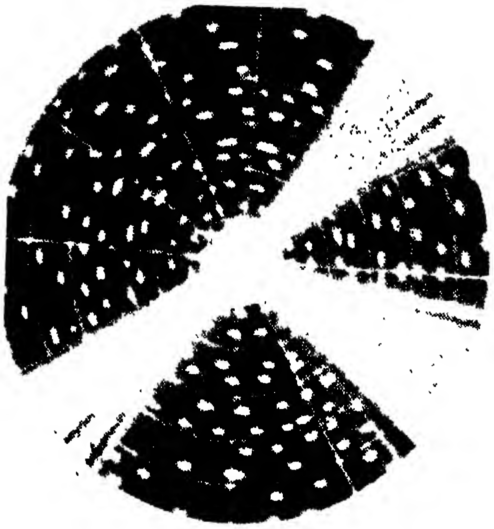
Human agents, whether working singly or in teams, could never hope to cope with the quantum and kind of intelligence that is required by their principals nowadays. It is no longer a question of going after a particular weapon blueprint or a treaty document: intelligence of all sorts is collected *en masse* and stored on tapes or in computers, on the principle that in a jumble of a million information bits there will be one that will make a jigsaw puzzle meaningful.

Electronic analysis

Various mechanical means are nowadays employed in intelligence gathering. They may take the shape of listening posts close to the enemy's border or spy planes (manned or unmanned) or reconnaissance satellites. At the headquarters of the network, the incoming traffic is studied for its physical qualities as well as its hidden messages. Thus, the movements of a warship can be accurately charted from small peculiarities of its transmitter, not detectable by the human ear but revealed by electronic analysis. Tapes and cathode-ray

"Time division" scramble of a stream of speech, as revealed by a sound spectrograph



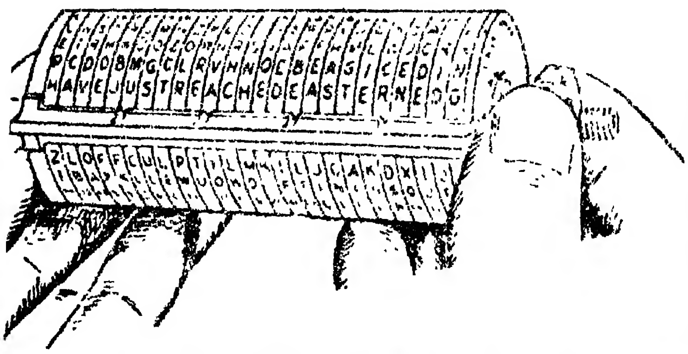


A radar screen is jammed with noise and false " blips " to confuse defences

photographs reveal a radar's " electronic signature " i e, its frequency, type of modulation, pulse shape and rate, power, type of scan, antenna-rotation rate and polarisation. These characteristics show a radar's function — search, height finding or target guidance. Such data help defences devise counter-measures like dropping metal chaff to confuse radars or emiting fake " returns " that clutter a radar screen with false blips.

Mobile units like trawlers are particularly useful in interception. The *Pueblo* had a long line of hydrophones which trailed behind it in the water, collecting the " signature " sounds of ships within a radius of 80 km. Among its other equipment were: radar equipment designed to bounce signals off the troposphere, giving it yet another way to listen to or to transmit messages; a dome-shaped antenna pointing skywards — probably the chief means of communicating with planes and listening to conversations between pilots. Since the *Pueblo's* capture, the US uses regular warships for surveillance work, rather than unarmed trawlers.

One advantage enjoyed by such mobile ferret craft is that whereas a man caught spying would be punished, a trawler could do its eavesdropping with impunity provided it remained outside the enemy's territorial waters. Even more immune are the spy satellites whose " folded " cameras, having a focal length of 305 m, can pick out the names on lorries from 300 km above. Their military tasks may include photographing the launching of missiles and the trajectories of their warheads. It was spy satellite photographs of newly constructed missile silos around Moscow that led the Americans to embark on the construction of an anti-ballistic missile system. The US is now believed to be designing a satellite which will cut down transmission time by hours. It normally takes days to get back film from satellites, even employing television-style cameras. The new satellite's cameras will translate what they see



Cypher cylinder: the message — " have just reached eastern edge " — is spelt out by aligning the discs. What is actually transmitted is any other row. Receiver adjusts his cylinder to this row and reads the actual message

"TOP SECRET"

US President Nixon last month came down heavily on classifiers of all sorts when he signed an executive order making it more difficult to classify a document as secret.

One reason for the proliferation of intelligence activity is the increasing tendency for governments to be secretive. The Pentagon is said to have a passion for stamping documents as " secret ", while Soviet agents equally passionately believe that anything deviously acquired —even the New York Telephone Directory — is of value. There is a Parkinson's Law in the field of espionage too : "Intelligence agents make work for one another."

They also multiply their subordinates. In 1928, US Secretary of State, Henry L. Stimson was shocked to learn that the State Department had a cryptographic bureau, and said : " Gentlemen do not read other people's mail." Today the Central Intelligence Agency which has a finger in every political pie has 15,000 employees in Washington alone, with several thousand agents abroad.

Holmes as Code-breaker

Here is a simple code message from A. Conan Doyle's story "The Gloria Scott". Why did the father of Sherlock Holmes' client go into shock on reading it?

" The supply of game for London is steadily going up. Head-keeper Hudson, we believe, has been now told to receive all orders for fly-paper and for preservation of your hen-pheasant's life."

Holmes concluded after careful scrutiny that the true message was every third word: " The game is up. Hudson has told all. Fly for your life."

The extra words mostly refer to sport, and Holmes astutely deduced that the writer was either an ardent sportsman or interested in breeding.

into electronic signals which can be transmitted to communications satellites. In this way, pictures can be relayed to Washington quickly.

Spy planes

A more flexible device and one that moves at lower altitudes is the " drone " or unmanned plane. The great thing about the drone is that it will blow itself up when something goes wrong. A US firm has now produced a new unmanned reconnaissance plane, the L 450F, which can stay in the air for more than 24 hours, has a range of 9,660 km and will climb up to 15,850 m; its electronic intelligence and reconnaissance capabilities would allow it to replace risky missions by sailors and pilots.

Cyphers

Most " intercepting " is merely a matter of listening to what flashes past in the ether. The real battle of wits takes place between the cryptologists of the countries involved — the men who make their own nation's communications unintelligible to others and break the codes and cyphers of other countries.

A code consists simply of a list of words and of letters or numbers arbitrarily chosen to stand for them. An everyday example is the code numbers employed for sending greetings telegrams in India. A cypher, on the other hand, encrypts individual letters. A small field code may consist of a few hundred words and phrases, while a diplomatic or naval code may contain 100,000 words. A code can often be broken by finding out the symbol for " period " or the end of the sentence because a message can be understood by finding out where sentences end. Cryptanalysts can break even the most elaborate code: by using mathematical means they strip off the " superencypherment " to get at the code groups.

A message is cyphered nowadays by machine. A cypher machine will produce the encyphered message as fast as the original is typed out. Elaborate machines are now used to produce cyphers more unreadable than hieroglyphics. The most widely used cypher machines have a set of wheels called rotors; each rotor has 26 electrical contacts on each face for the letters of the alphabet. The message is typed out on a typewriter-like keyboard. When the letter " a " on the keyboard is struck, it connects to the rotor's " a " contact, but on the other side of the rotor this comes out as " s " or some other letter. Each succeeding rotor changes the letter to something else, and since the rotors turn after each letter is encyphered — at different rates relative to each other — each succeeding letter of a message is put in a different cypher. Thus, a cypher machine can transmit the contents of an entire bookshelf in code before it repeated itself.

The unbreakable cypher machines — which are also used by the Washington-Moscow " hot line " — look and work like standard teletypewriters systems, except that in addition to the punched tape with patterns of holes for the letters of the alphabet, there is a " black box " containing a tape perforated with letters absolutely at random to form a cypher key. The message tape and the key tape run simultaneously to yield combined and cyphered

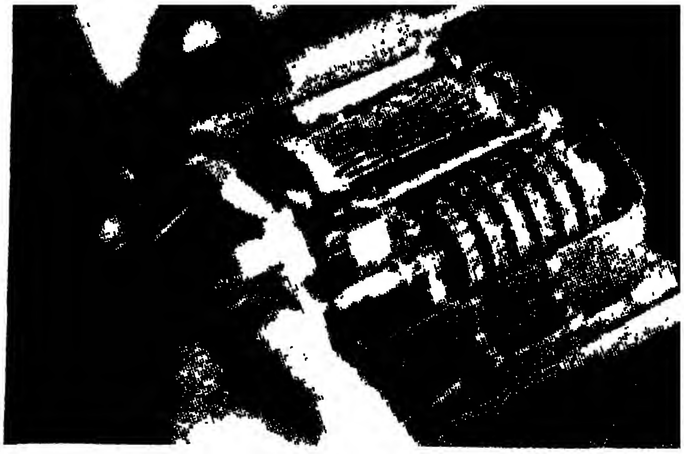
Voice scrambler

THE MANY WAYS OF SNOOPING

Not all messages are sent in codes or cyphers, because these can be stolen. Other methods employed by intelligence are :

- *The microdot :* By photographic means a technical drawing or a printed page can be reduced to a microdot, no larger than a printed full stop. The page is first photographed down to the size of a postage stamp, and a second photograph reduces it to a dot of less than 0·12 cm diameter. With a needle-like implement the microdot is then lifted from the photographic emulsion and cemented with collodion over a full stop in an ordinary printed book. Rudolf Abel, the Russian agent who was captured by FBI men in his New York room in 1957, made his own microdots by reducing 35 mm negatives with a lens of extremely short focal length and preserving its legibility by using spectroscopic film.
- *Invisible ink :* Modern types of invisible ink cannot be made visible just by heating but can be developed only by certain chemicals. An iron sulphate preparation shows nothing until painted over with potassium thiocynate, when the invisible writing turns blood-red. Fluorescent ink is unseen by daylight but glows in the dark under an ultraviolet lamp.
- Not long ago, top American diplomats were holding a conference in Moscow, but the Russians heard every word. They had " bugged " the plaque of the American Great Seal on the wall by planting a special reflector in it. From 300 metres away, an invisible infra-red beam of light was aimed at the plaque and electronics did all the rest.
- Other long distance devices are the *ultrasonic microphone* which can penetrate any material ; and the *infra-red microphone* which modulates a light beam through an infra-red filter — the vibration of a cocktail glass may be sufficient to transmit the speaker's voice, which is then converted into invisible infra-red light waves.
- When conversation is to be monitored or recorded continuously, without any tell-tale signs of tampering, a wafer-thin microphone is ideal. Slipped under a slit in the wallpaper or a drawer, it has no wiring to give it away. Conductor paint invisible to the naked eye, runs to some part of the house or office where it can be met with a wire and connected to a tape-recorder some distance away.

Snooping is not limited to intelligence agents alone. In the US, filching of industrial secrets is routine for business executives whose innocent-looking tie clips may conceal tiny microphones wired to miniature tape-recorders in a suit pocket.



The Hagelin cypher machine has six wheels with adjustable pins that help create a gear with a variable number of teeth

electric pulses. In the receiver, at the other end, there is a black box which contains an exact duplicate of the key-tape; this removes the encypherment and prints out the message. What makes the cypher unbreakable is that a key tape is used only once. The chief drawback with such machines is that huge quantities of duplicate one-time tapes have to be prepared, transported to receiving centres and filed for use in precise order.

Scrambling

Another way of sending a message is by scrambling it — by making the human voice unintelligible eg, by altering normal voice frequencies. One way of doing this is to chop up a tape recording of a speech into split-second divisions and shuffling them by picking off the segments in jumbled order from as many as five pickup heads. The latest " pulse code modulation " scrambler converts the voice signal into a series of pulses and non-pulses, somewhat like a teletypewriter signal. The pulse frequency varies with the voice frequency, is in digital form and can be encyphered.

When a code is broken, it is necessary to be discreet in using the information gathered, lest the enemy get alarmed and change the code.

The last word

The Achilles' heel of an intelligence set-up is, of course, the human element. Most networks are infiltrated by the double agent who works for both sides. Perhaps the last word on this dirtiest of all games was Khruschev's remark to Allen Dulles, then Director of the CIA, during his 1959 visit to the USA: " We should buy our intelligence data together and save money. We'd have to pay the same people only once."

FIREFLIES

SUMATI K. SAMPEMANE

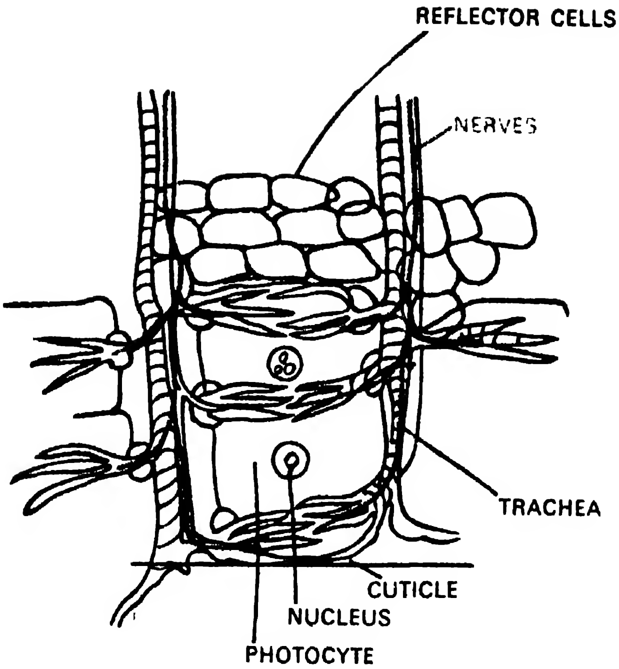
HAVE you heard of the ignis-fatuus, the mysterious light that leads unwary travellers to their doom? Some call it the will-o'-the-wisp. Some call it Jack-o'-lantern. It is the light of combustion of marsh gases. There are other mysterious lights too. Some deep-sea fish carry glowing headlights. There are luminous mushrooms and earthworms and caterpillars. Most of them glow with the borrowed biological light of the bacteria living in them. These bacteria may be symbiotic (as in deep-sea fishes) or parasitic (as in certain caterpillars) in which case the host is doomed to a glowing death.

But there is one insect that has a biological light all its own. This is the benign firefly. The natives of the West Indies have at one time even used these fireflies to light up their dwellings. They also tied them to their feet to light their way along dark forest paths. And their women used them as decorations for their hair! The firefly's is not a bacterial light. At one time many thought it was — for the light-producing cells bore a remarkable resemblance to microbes. But when these cells were removed in the larva, the subsequent pupa was non-luminous. The emergent adult, however, did not lack in the light-producing cells. Unless, of course, these bacteria undergo a non-luminous stage in their life cycle, this luminosity cannot be attributed to them.

Then again, the light was thought to contain phosphorus because its radiations are similar to those of phosphorus. But in 1886, Dubois proved that the firefly's light came from an enzymatic reaction. He removed two luminous organs from the thorax of the firefly of the genus *Pyrophorus*. He ground one till all its light radiation stopped after the consumption of all the photogenic material. He dipped the second organ in boiling water till its light too was extinguished. He then mixed the two and lo there was light again! Which all went to prove that though the enzyme was destroyed by boiling water, the substrate was not. It was reactivated by the enzyme present in the ground organ. The substrate in the cells is a substance called luciferin. It is oxidised by the enzyme, luciferase, to give light. The substrate and enzyme differ slightly in the different species. If luciferin from one genus is mixed with the enzyme from another genus, the light produced differs from that which would have been produced by the organ of the same genus. Luciferin has been synthesised but the exact mode of its utilisation in the biochemical reaction by the insect is not known. The reaction involves the use of luciferase, oxygen and a chemical known as adenosine triphosphate (ATP) which supplies the energy. While in other cells chemical energy yields mechanical energy, in photogenic cells it yields light.

The photogenic cells may be a modification of any organ like the epidermal cells or the excretory organs or the salivary glands. Primarily they are the fat bodies that are modified for light production. They are covered by a thin transparent layer of cuticle and are supplied with numerous air tubes (to ensure abundance of oxygen) and nerves (to control the lighting). To enhance the brilliance of these organs they are backed with a layer of white cells containing ammonium urate which acts as reflectors (see figure on page 56).

Fireflies are very efficient light producers. A minimum of energy is lost as heat. (The light efficiency of a source is the ratio of visible radiant energy to the total radiant energy emitted by it. When energy is used for lighting, only a fraction of it is converted to light energy, the rest is dissipated as heat.) The heat produced in the *Pyrophorus* is equal to 1/80,000th of a candle flame of the same intensity. In some species the efficiency is as high as 87 per cent to 92 per cent and above. In contrast, the efficiency of a carbon filament lamp is a mere 0·45 per cent, of a gas-filled tungsten filament lamp 5·5 per cent and of sunlight 25 per cent. If it were possible to obtain artificial lighting of such efficiency, the expenditure could be cut down to a fraction of the present value. The one great disadvantage would be that all objects would have a uniform greenish tinge. The colour of the light varies from bluish-green to golden-red. The difference is probably due to the scattering by the proteins. This cold light is almost free of infrared



LUMINOUS MECHANISM OF THE FIREFLY

and ultraviolet rays and falls mostly within the narrow yellow-green band of the visible spectrum. Apart from its narrow band the light differs in no way from ordinary light. It can be polarised, used for photography and for the production of chlorophyll in plants.

Light produced by the various living organisms serve different purposes. For some it is a byproduct of metabolism. For others, such as the firefly of New Zealand, *Bolitophila luminosae* (it is really a gnat), it serves as bait to draw the prey into the silken strings it drops from the roof of the dark caves it inhabits. Still others, like the fireflies, use light to deter foes. The flashings which have a definite pattern and wavelength in each species also help in attracting the opposite sex.

No other living creature has a photogenic organ of such complexity or luminosity as the firefly. These photogenic organs may be found anywhere from the head to the tip of the abdomen and they vary in size from pin head dimensions to masses occupying a greater portion of the lower surface of the body. The most luminous species belong to the genus *Pyrophorus* (an Elateridae beetle) found in the West Indies. They have two lights at the beginning of the thorax with a yellowish-green tinge and another orange light at the ventral tip of the abdomen which can be seen only during flight.

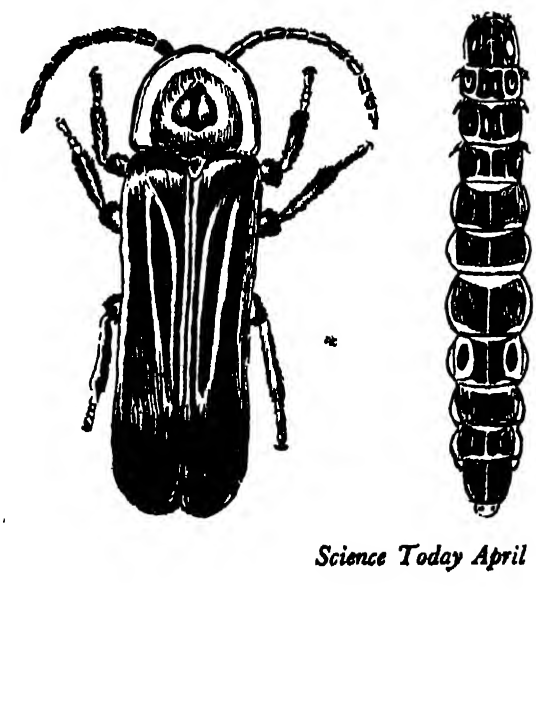
It was estimated that 37 or 38 of these insects gave out light equivalent to the light of one candle. The light of one insect is sufficient to read even small print. The railroad worm of South America is yet another peculiar glow worm. It has a red headlight and yellowish-green lights along its side.

Fireflies are not really flies nor are they worms. They are beetles and are grouped in the order Coleoptera. The 2,000 species of luminous beetles are classified in two main families, the Lampyridae and the Elateridae. Both adults and larvae of these families glow and often even the eggs and pupa are luminous.

In the Lampyridae (only the luminous species are found in India) the photogenic organs are placed at the tip of the abdomen on the ventral side. In the Elateridae they lie on the pro-thorax. The former are tan, brown or blackish with soft wings. In some species the females are wingless and look like worms — hence the name glow worm. In some other species of this family the insects cluster in groups and flash out simultaneously for long periods. What stimulates this reaction and what it means are not known. This group glowing continues for days or weeks or even months at a stretch, regardless of weather. But it stops in bright moonlight.

Beetles of the family Elateridae are also known as click beetles because of their ability to jump back to their feet when upturned. They are hard-bodied insects and are considered as root pests. None of the Indian species, however, are regarded as pests. The luminous Elateridae beetles are found only in the tropics of the Americas.

The firefly, *Photinus pyralis*

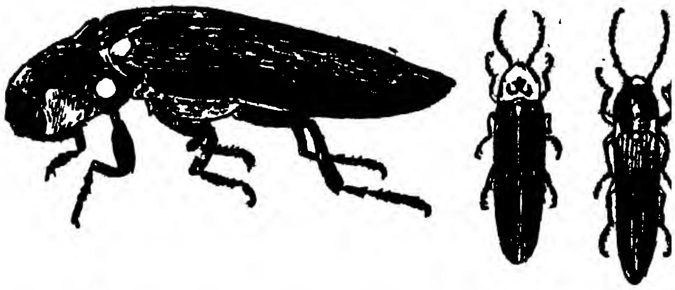


Fireflies seek their mates by flashing out signals. In some species the females have a brighter light while the males have sharper eyes. The female takes up a prominent position and lights up till a suitor flies to her. In the species, *Lampyris noticula*, the female's light is visible up to nearly 90 metres under suitable conditions. But there are many species in which the males are more brilliantly lit.

The female lays its eggs in the earth or on grass stems. The eggs too are often luminous. In fact, the abdomen of some females glow because of the presence of the luminous yolk of unfertilised eggs. After about a fortnight the luminous larvae are hatched. The larvae light up when alarmed to deter their foes, but adults switch off their lamps when approached to hide themselves. The larvae develop in a series of moults over a period of two to three years before they enter the pupal stage. The voracious larvae feed upon snails and slugs by following up their slimy trails. The other items of food are other insects and their larvae, earthworms and crustacea (the crab family). They have a unique way of feeding. They paralyse the victim by biting and injecting it with certain juices which also partially digest the insides of the victim into a gruel that is sucked in. Whether adults feed at all is a disputed question but in some species they are said to be as predaceous as the larvae. After a meal, the larvae push out a spongy substance from the anus to prop up the slimy remains from their bodies. The females of some species thrive on the males of other species. They flash their lights to attract males. The unwary males come, mistaking them for prospective mates, but end up by becoming a meal. Since a firefly can tell a male of its own species from that of another it rarely kills a genuine suitor though this too happens occasionally.

The short pupa stage which is also luminous is followed by the adult phase. In species where the females are wingless the pupae of the two sexes differ. The adults emerge after eight or nine days. They inhabit marshy areas where abundant food is available. In the day time they hide in cracks and crevices and come out at dusk to search for food and mates.

Though their luminous bodies make them distasteful to certain foes (like birds and bats) this does not prevent frogs, toads, spiders and hedgehogs from making a meal of them. (When a frog greedily gulps down innumerable fireflies it too begins glowing in the dark.) Soon after a moult, fireflies are susceptible to mites which attack the skin between the segments. Modern insecticides and urbanisation have also limited their numbers. But the strangest thing is that males often seem to prefer artificial light to their mates and are singed as a result.



The fire beetle *Pyrophorus pellucens* Eschschottz (left), the Lampyridae (centre) and Elateridae (right) of the order Coleoptera

Maybe, in time to come, man will learn the full secret of the glow of the glow worm. But maybe man is a step ahead after all. He has been able to produce efficient chemical light-producing systems that are far more brilliant than the glowing, greenish-tinted light of the firefly.

VITAMIN E

Clearing up some myths

VITAMIN E was discovered in 1922. Since then nutritionists have found countless curing qualities in it. It is claimed that vitamin E increases fertility and sperm count, helps the ovaries, prevents abortion, and congenital deformities in babies. It can cure cold, alcoholism, cirrhosis of the liver, chronic constipation, peptic ulcers and even some brain and neurological disorders. As a tranquilliser, it calms the nerves and normalises blood pressure. It helps in the treatment of diabetes and heart diseases. In children, it cures mental retardation and eye defects. Among its positive qualities, it strengthens bones, teeth and the muscles, and improves the circulatory system. It banishes vericose veins and swollen ankles, loosens up blood clots and heals wounds and burns. It even slows the aging process. The list is growing.

That would make the vitamin almost a panacea. But are the claims true ? Physicians tend to prescribe vitamin E in many cases which have no known cure. For the usual argument is that vitamin E (alpha-tocopherol, chemically) is non-toxic, and if it can do no good to the patient, it cannot harm, either. (But in some cases vitamin E has been found to have adverse effects, see box.) And as physicians began to link both real and psychological responses in patients to the vitamin, many beneficial qualities came to be tagged on to it.

What does the vitamin exactly do in the body ? To know this, scientists produced artificial deficiencies of the vitamin in rats. Any symptoms observed were related to the deficiency. But such experiments can be subtly manipulated to produce different symptoms in different species. The one consistent result of the experiments is that the dificiency of vitamin E can damage red blood cells. All other secondary ill-effects can stem from this. The deficiency leads to a type of anaemia in premature babies. After examining 234 cases, two US researchers found that haemolitic anaemia occurs in premature infants lacking the vitamin. The disease was cured by giving the babies vitamin E orally.

Scientists tend to think that vitamin E strengthens cell membranes which in turn protects red blood cells. Studies have shown that there is a close relation between vitamin E and polyunsaturated fatty acids (PUFA) — fatty substances forming the cells with proteins and carbohydrates. These partially oxidised fatty substances in cell membranes shield the cells. Vitamin E, it has been found, prevents these substances from complete oxidation. (Complete oxidation can damage intracellular membranes, enzymes and certain metabolites.) And when the body lacks the vitamin, the fatty substances in the cell membrane get oxidised and fail in their function ; the cell membranes now break down and haemoglobin in the red blood cells escapes from the cells, leading to anaemia.

This has, however, not been conclusively proved. Some think that cell membrane failures could be explained in other ways too. Besides, the phenomenon has so far been observed only in the laboratory and not in the body. To sum up the present state of the studies, according to J. A. Lucy of the University of London's Royal Free Hospital : "Vitamin E fulfils a physicochemical role in the stabilisation of cell membranes". And since these membranes protect cells and receive enzymes on them, vitamin E deficiency could inhibit either or both of these functions. Here some finer experimental points have to be settled.

How much of the vitamin does a man need, anyway ? Is there a deficiency in the general diet ? Though there are no experimental standards, nutritionists recommend 5 milligrams a day for infants and 30 milligrams for adults. But studies in England showed no ill-effects though 50 per cent of the normal diet had only 5 mg a day and some even below 3 mg. Since the vitamin occurs in cereals, wheat germ oil, egg yolk and milk, it is thought that there need not be any general deficiency, and hence no need for an extra dose.

How safe is vitamin E?

Many presume that vitamin E is non-toxic, and that "the vitamin will probably do no harm and probably no good". But in large doses, the vitamin can lead to heart failures in patients with chronic rheumatic hearts, says Dr. Evan E. Shute of the Shute Institute for Clinical and Laboratory Medicine, Ontario, Canada.

In another case, small amounts of the vitamin, taken alone, caused high blood pressure for about a day. This extreme reaction may not be common but some think that vitamin E may not be safe to take alone and that it must be taken together with unsaturated fatty acids.

Did the stars foretell?

LOOKING BACK...

JOHANN KARL FRIEDRICK GAUSS (30 April 1777) : Gauss was the son of a bricklayer who wanted him to remain a labourer. Had he abided by his father's wishes, we would have lost one of the greatest mathematicians in history. For he had touched practically every branch of mathematics, besides astronomy and physics. In fact, Gauss is ranked with Archimedes and Newton, though in many respects he surpassed both.

Gauss's first important published work was his dissertation for graduation, *Disquisitiones Arithmeticae* (1801), in which he propounded the Method of Least Squares, by which the best equation for a curve fitting a group of observations can be made. He showed how an equilateral polygon of 17 sides could be constructed using straightedge and compass alone. He also studied the theory of errors wherefrom he evolved the normal curve of probability, known as the Gaussian curve.

His work on non-Euclidean geometry became known to the world after his death. In collaboration with his pupil Reimann he worked out a set of units of measurement for magnetic phenomena. The unit of intensity of a magnetic field was named "gauss" in his honour.

Outside the realm of pure mathematics his best known work was on Ceres, the first planetoid to be discovered. Using a few of Piazzi's data and his own Method of Least Squares he correctly predicted the location of the planetoid.

WILLIAM HARVEY (1 April, 1578) : Galen the Greek physician had noticed the separation of the right half of the heart from the left by a thick wall. He knew that fluid from the left half had to get somehow to the right half. He postulated the presence of minute holes in the wall, to get over the difficulty.

It was left to Harvey to solve the mystery. Through actual dissection he showed that there were one-way valves in the heart which allowed the blood to flow from the auricles (upper chambers) to the ventricles (lower chambers). During his studies at Padua he had noticed that there were one-way valves in the veins, too. Blood in the veins could only travel towards the heart and not away from it. Harvey thus established that blood flowed circularly in one direction and that it was not a to-and-fro motion as Galen had supposed. He was not able to prove how blood passed from veins to arteries, but noticing that blood vessels divided into smaller and smaller vessels till they became invisible, supposed that the connecting vessels were too small to be seen by the naked eye. Four years after his death he was proved right by Malpighi who saw these "capillaries" under the microscope.

Harvey worked out, further, that in one hour the heart pumped a quantity of blood that was three times the weight of a man. It seemed inconceivable that all the food eaten by a man could produce so much blood. Therefore it was the same blood that was kept in motion, i e circulated, by the heart.

Harvey was naturally ridiculed for refuting Galen, but lived to see the triumph of his theory.

CHRISTIAAN HUYGENS (14 April, 1629) : In 1656 a Dutch scientist, Huygens peering through his improved telescope at Saturn noticed something that is still unique in the known universe : the planet was surrounded by a ring which did not touch it. He announced his discovery in cypher, a custom common among scientists of his day who wished to avoid persecution for heretical views.

Huygens has many "firsts" to his credit — the discovery of a large satellite (Titan) of Saturn, of the constellation Orion. He saw, however, that to study the motions of heavenly bodies accurately would require quantitative measurement of space and time. To do the former he devised a micrometer which could measure angular separations of a few seconds of arc. To measure time better, he made use of Galileo's observations on pendulums; he devised attachments at the pendulum's fulcrum that would make it swing in the proper arc, and connected it to the gears of a clock so that falling weights would transfer just enough energy to the pendulum to keep it swinging. This was the first "grand-father's clock".

He endeavoured to refute Newton's view of the corpuscular nature of light. According to him, light could be thought of as a longitudinal wave and this was quite consistent with the propagation of light in straight lines and with the laws of refraction and reflection. Newton's theory however held the field till Thomas Young revived the wave theory in the early 19th century. Still later, the Quantum Theory showed that light could be treated as both a wave and a particle, thus bringing the two theories together. Huygens died on 8 June 1695.

Huygen's pendulum

LEONARDO DA VINCI (15 April 1452) : Though most people know of da Vinci as the painter of " La Gioconda " (popularly known as the Mona Lisa — the owner of the most mysterious smile that artist has depicted on canvas), this Italian genius of the Renaissance dabbled in a great many fields — hydraulics, mechanics, aerodynamics, astronomy, geology, anatomy and what have you. It is only about a century ago that his note-books, numbering about 5,000 pages, were published, and gave the world the true sweep of the man. However, as they were written in mirror image, his contemporaries knew nothing of his ideas, which have therefore not contributed to the growth of science.

Leonardo understood the principle of inertia and anticipated the Copernican concept of the solar system.

He dissected numerous animal and human bodies and made drawings, not from a medical viewpoint, but from the engineering one. He designed flying machines based on his studies of birds' wings and bird flight, and submarines based on his studies of fishes. He was obviously a man who was far in advance of his time. He died on 2 May 1519.

MAX PLANCK (23 April 1858) : The Quantum Theory of the German theoretical physicist, Planck, marked the beginning of the revolution in physics. Put forward in the very first year of 20th century it was tested and strengthened by subsequent experiments of Einstein, Bohr and Millikan.

Planck was spurred by the failure of many scientists to solve the problem of " the distribution of energy coming from the black body at different temperatures ", and in an attempt to find his own answer, he suggested that energy — whether in the form of light or X-ray or electromagnetic (radiation) waves — comes from or goes back to the atoms of matter in packets, i e energy, like matter, existed in particles. Energy is emitted or transferred in successive small packets, each called a quantum, like " a jet of bullets " and not in a continuous flow like " a jet of water ". The size of the quantum for each form of electromagnetic radiation was in direct proportion to its frequency. Thus a quantum of violet light would contain twice the energy of a quantum of red light. The ratio of the frequency of the radiation and the size of the quantum is called Planck's constant and is written as *h*.

Planck's theory was so revolutionary that he himself did not believe in it at first. But as the years rolled on, its importance grew and Planck was awarded the Nobel Prize for Physics in 1918. Today Planck's name is commemorated in the Max Planck Society.

S. N. Munshi

DOES ANTI-MATTER EXIST?

The USSR Committee for Inventions and Discoveries has officially entered into the State Register the discovery of anti-helium nuclei produced in the Serpukhov synchrotron by scientists of the USSR Academy of Sciences. The experiment required the construction of a complex installation which included more than 50 high-speed detectors and electronic devices capable of recording processes taking place in 0·0000001 second. In the process of measurements, over 200 billion particles were put through the installations and five nuclei of anti-helium-3 were found and identified among them. Soviet scientists claim that anti-elements of all elements in the periodic table may be constructed in this manner.

The concept of anti-matter is rather illusive. The anti-matter theory was formulated a long time ago, but it is only during the last 40 years that scientists from Japan, the USA, the USSR and other countries have actually proved that certain particles do have a twin particle with the same properties but an opposite electrical charge. It was discovered that when these particles collide they are annihilated and in the process release a tremendous amount of energy. From a practical point of view, research in this area is most promising since it can provide a method for producing a new and powerful energy source.

Theoretically, the anti-matter concept has excited the imagination of many researchers. Hans Alfven, the Swedish physicist who was awarded the 1970 Nobel Prize, made the assumption a few years ago that the universe was composed of galaxies and anti-galaxies and that matter and anti-matter are intermixed in each galaxy. Alfven thinks that the quasars, the nature of whose extremely high-capacity sources of radiation has not been explained as yet, are galaxies which are in the initial stage of their evolution and which emit energy released by the annihilation of matter and anti-matter.

CODE PRACTICE OSCILLATOR

International Morse Code

A	· —	J	· — — —	S	· · ·
B	— · · ·	K	— · —	T	—
C	— · — ·	L	· — · ·	U	· · —
D	— · ·	M	— —	V	· · · —
E	·	N	— ·	W	· — —
F	· · — ·	O	— — —	X	— · · —
G	— — ·	P	· — — ·	Y	— · — —
H	· · · ·	Q	— — · —	Z	— — · ·
I	· ·	R	· — ·		

0	— — — — —	5	· · · · ·
1	· — — — —	6	— · · · ·
2	· · — — —	7	— — · · ·
3	· · · — —	8	— — — · ·
4	· · · · —	9	— — — — ·

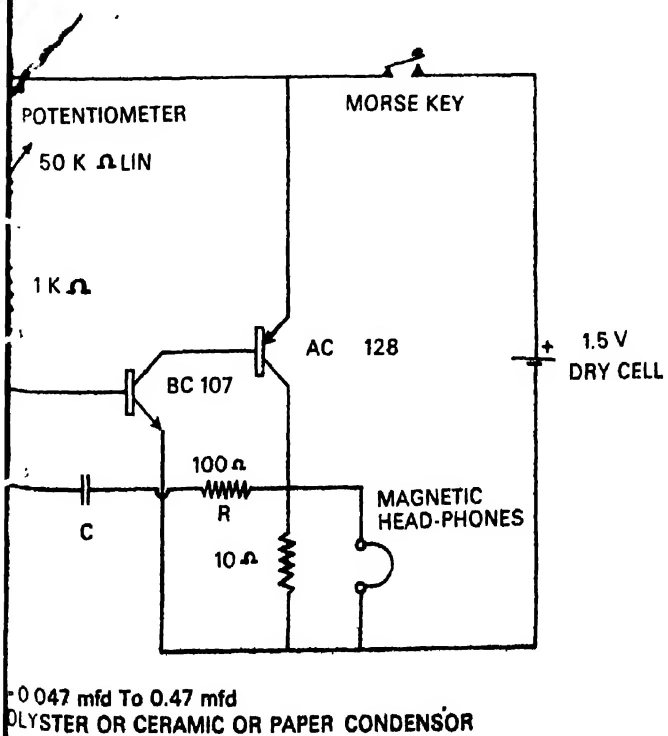
Distress Signal SOS · · · — — — · · ·

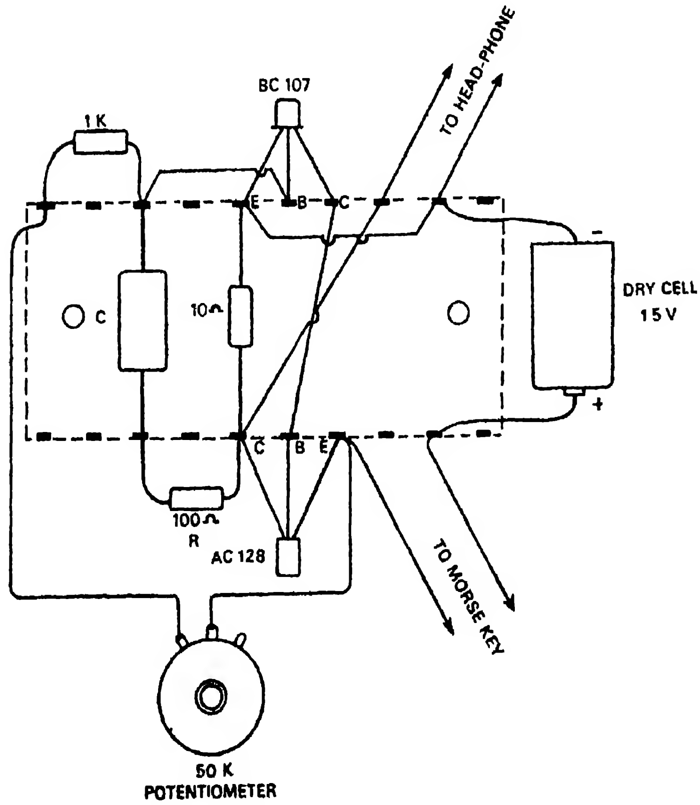
Time for a dash is equal to three dots, and the interval between two alphabets is equal to time occupied by three dots. Similarly the interval between two words is equal to time occupied by five dots

Above: The international morse code. Below, left: The circuit diagram of the code practice oscillator. Below, right: The wiring of the circuit.

OF the many means of communicating in code, the morse system is the internationally most well-known. It is basically continuously fluctuating electricity that represents letters and numbers. The shorter fluctuations are written on paper as dots and the longer ones are the dashes. In this way, each alphabet from A to Z and each number from 0 to 9 has its representative and unique set of dots and dashes.

Very often, you might have heard this code transmission over the air when you tuned in on the shortwave stations on your radio. And if you wish, you could build a set to practise on.





The code practice oscillator described here is very simple to construct as it has very few components.

The CFO is basically an audio oscillator. The resistor R and the capacitor C form the feedback path. The frequency of oscillations can be changed to achieve a suitable tone by replacing the capacitor C with the suitable value. Though the potentiometer is used for adjusting the bias current of the first transistor it does change the tone also to some extent. The morse code key is in series with the battery and the circuit. Thus when the key is not in use there is no battery drain.

You will need:

Transistor: BC107 or BC108 or BC109, 1 piece, AC128 or AC126 or AC125, 1 piece. *Resistors* (all ½ watt): 1 K ohm 1 piece, 100 ohms 1 piece, 10 ohms 1 piece; *Potentiometer:* carbon or wire-wound linear, 50K ohms without switch, 1 piece; *Condensors* (polyester or ceramic or paper): 0·047 mfd 1 piece, 0·1 mfd 1 piece, 0·22 mfd 1 piece, 0·47 mfd 1 piece. Morse code key 1 piece. Magnetic headphone 1 piece, Battery: 1·5V dry cell 1 piece; *Misc:* Lug strips or group board, wires, solder, screws, suitable enclosure.

Anil V. Borkar

BRAIN TEASERS

Those expensive spoons

" Nearly ten rupees for a dozen spoons! " Sita exclaimed, passing the letter to her husband. " I can get thirteen of them here in Madras for ten paise less."

Manohar glanced at the letter. " They say postage will be extra on top of that. Are you sure the one's here are the same? "

" I was with Lakshmi when she bought some yesterday, and I saw what she paid," Sita nodded. " They were priced singly, all the same price, the same as the mail order ones are."

What was the local price?

Paper chase

It's a mere ten kilometres to Bombay. Ramu set out at a leisurely three kilometres per hour. But when he was exactly halfway there, he had to go back to his starting-point to collect some papers he had forgotten. Luckily, a friend's house is just at the half-way point between his home and Bombay and she lent him a cycle on which to go back. Wasting no time, he got the papers and at once cycled all the way to Bombay. He reached there at the same time he would have done if he'd walked at his regular pace all the way without incident. So what was his cycling speed?

Up the boys

" My boys grow fast, both of them," commented Mr. Lamba. Asked how old they were, he explained:

" The difference between the cubes of their ages is only twelve less than a thousand and the difference between their ages is only four years."

How old are the boys?

Sharing mangoes

" Mangoes! " exclaimed Satish, looking into the paper bag on the table. " Let's have one, Uncle Suresh."

"Okay, but just a moment," replied Suresh. " We'll set aside a third of them, and a third of a mango for your mother. Then you take half what's left, and half a mango. That should leave two for me."

How many were there?

(Solutions next month)

Solutions to last month's Brain Teasers

1. Seventeen thousand rupees
2. The number of coins in each denomination is equal to the number of paise in that denomination. That is, one one paisa coin, two two paise coins, etc.

To be master of its own destiny a nation must be self-sufficient. And increasingly we must learn to cut down on imports. Or alternately continue to survive on the whims of others.

At Jhaveri Thanawala innovation means invention. In 1970 we invented FIBREGLASS FLEXIBLE CABLES, which will save India Rs. 18 lakhs in foreign exchange annually.

Just one example of what Jhaveri Thanawala are doing to meet the challenges of the 70s.

JHAVERI THANAWALA PVT. LTD.,

Manufacturers of Fibreglass Tapes, Cloth Sleevings, Glass Mica Sandwich Sheets & Glass Laminated Sheets, Fibreglass Adhesive Tapes, Braided or Twisted Cords.

47, Tamarind Lane, Fort, Bombay-1.
Phone: 294047, 318611. Telex: 011-3613

A Call to the Nation:

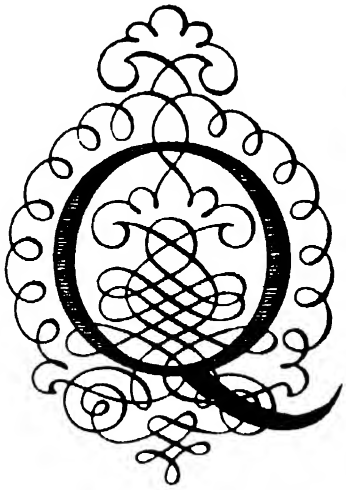
INNOVATE OR PERISH

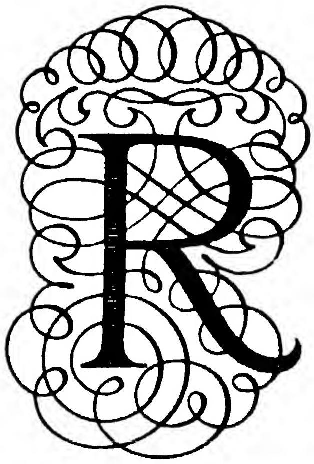
JAISONS-248

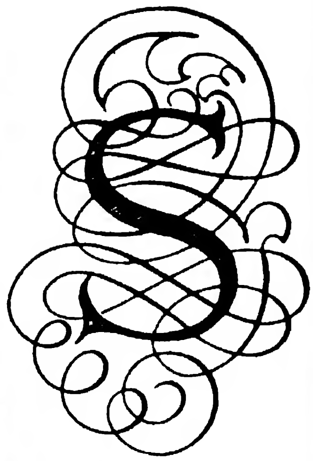
Bensons/5939

The combination that makes BDH chemicals so special:

QRS!







Quality
BDH has an established reputation as a manufacturer of top-quality laboratory chemicals and reagents. The purity of the BDH 'AnalaR' and other chemicals has been recognised internationally.

Range
The BDH range includes over 600 high-quality laboratory chemicals and is constantly expanding to meet the changing, challenging needs of education, research and industry.

Service
The BDH customers are kept regularly informed of additions to the range, and technical information on products is promptly sent on request.
In addition, the comprehensive network of stockists and dealers ensures the availability of BDH chemicals in any part of the country.

BDH Laboratory Chemicals

BDH Laboratory Chemicals Division, Glaxo Laboratories (India) Ltd., Dr. Annie Besant Rd., Bombay 18 WB

Regd. No. MH 1368

A TIMES OF INDIA PUBLICATION

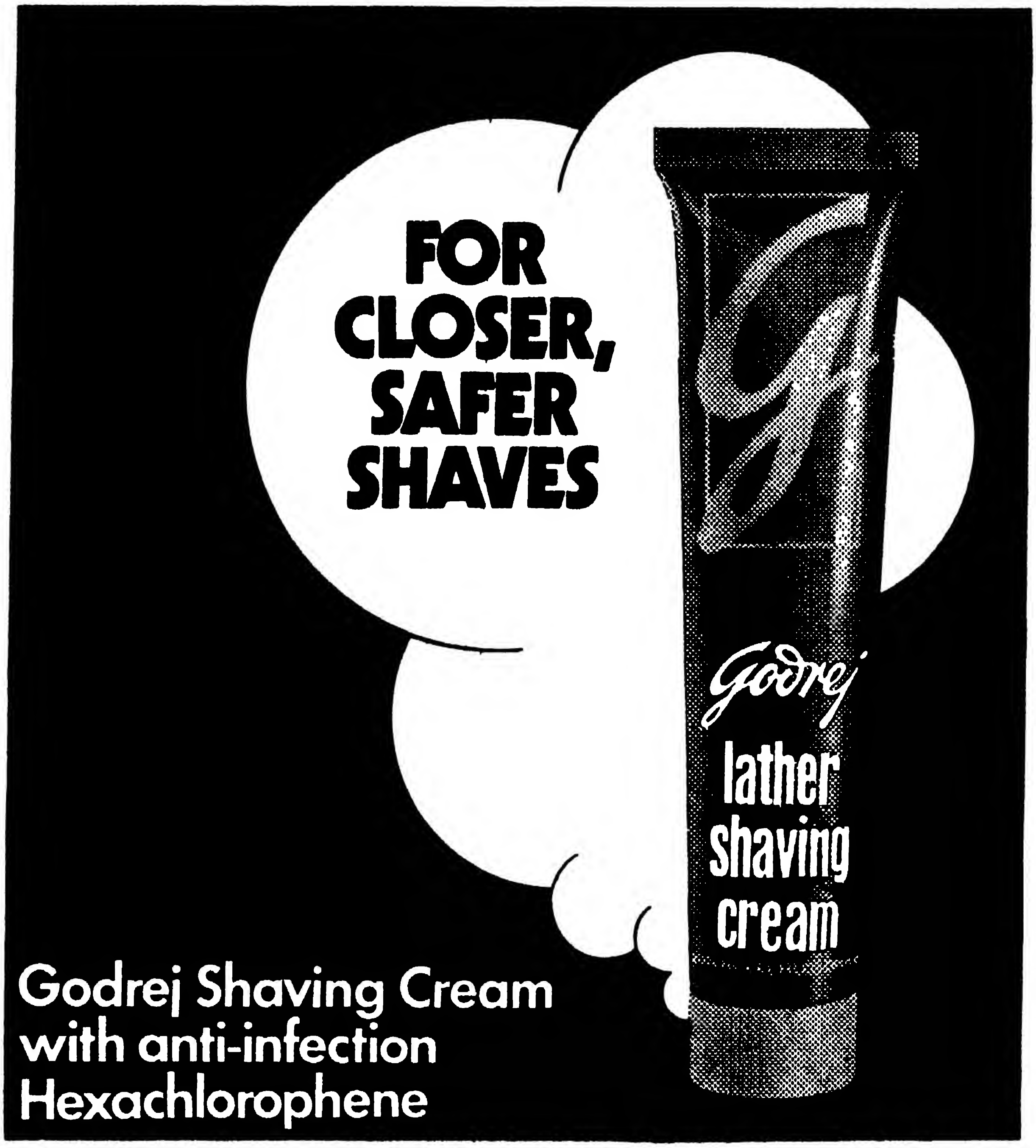
MAY 1972

SCIENCE TODAY

FOR EVERYMAN

FIRE AND BURNS

Rs. 1·25



Rich, lavish lather. The sure safety of anti-infection Hexachlorophene. That's Godrej Shaving Cream. In the smart red tube.

Godrej Brushless Shaving Cream for a quick,close shave, plus Hexachlorophene safety.

Godrej Mentholated Shaving Cream for a cool, clean shave, plus Hexachlorophene safety.

Try the 20 g. tube today! Ideal for travel.

CMGS-29-203 R

Vol. 6 No. 11 May 1972

SCIENCE TODAY

COVER The omnivorous fire and the hell of burns. (*Designed by Shabbir Diwan*)

Annual Subscription Rs. 12·50
Single copy: Rs. 1·25; 10p

Editor Printed and published for the proprietors Bennett, Coleman & Co., Ltd., by Pyarelal Sah at the Times of India Press, Bombay, India. Delhi Office: 7, Bahadur Shah Zaffar Marg, New Delhi 1;

ABOUT THE AUTHORS

M. H. KESWANI

M. H. KESWANI and NARENDRA J. PANDYA (*Burns*) are with the Tata Dept. of Plastic Surgery, at the J. J. Hospital, Bombay. Dr. Keswani heads the Burns Research Unit at the hospital. He had specialised training in burns treatment in the UK and USA. He represents India in the Governing Council of International Society for Burn Injuries.

N. J. PANDYA

Dr. Pandya is with the Tata Department of Plastic Surgery. He returned to India recently after extensive training in plastic and reconstructive surgery in the USA. An FRCS, he is also a diplomate of the American Board of Plastic Surgery. He was the Organising Secretary of the National Multidisciplinary Symposium on Burns held in Bombay last January.

● ●

A. A. KARANDE (*The Not-so-silent Sea*) belongs to the Defence Science Service and heads the Applied Biology Group at the Naval Chemical and Metallurgical Laboratory, Bombay. For his doctorate from Bombay University, he did cytochemical studies of the mammalian liver at the Institute of Science, Bombay. Dr. Karande is currently working on marine bio-fouling and the microbial deterioration of aviation fuel and industrial fluids. He had taken part in the first three cruises of the Indian Ocean Expedition and was associated with plankton sampling.

● ●

K. S. MANI (*The Mystery Disease from South India*) is Professor of Neurology at the All-India Institute of Mental Health, Bangalore. He is the president of the Neurological Society of India and is also a Fellow of the Indian Academy of Medical Sciences.

● ●

U. R. ACHARYA (*The Atomic Clock*) is director of the Instruments Division at the Meteorological Office, Poona. He is a Fellow of the Royal Meteorological Society.

● ●

K. PRABHAKAR NAIR (*Fire! Fire!*) is on the staff of SCIENCE TODAY.

AWARDS & APPOINTMENTS

Royal Society Honour for Indian Scientist

Dr. B. P. PAL, who has been elected Fellow of the Royal Society, London, is internationally known for his contributions to wheat breeding. He recently relinquished charge as Director-General of the Indian Council of Agricultural Research, having been the first scientist to hold that post.

Dr. Pal did his Ph D in Plant Breeding and Genetics at Cambridge. He joined the Indian (then Imperial) Agricultural Research Institute as Second Economic Botanist and later became head of its Botany Division; in 1950 he became Director of the IARI.

In collaboration with Dr. K. C. Mehta, he crossed wheat varieties having genes for rust resistance with those having good grain quality and high yield. The result was the NP 700 series of wheat which gave a good account of themselves in years of wheat rust epidemics. The variety NP 809, released in 1954, was the first wheat variety to possess resistance to all the three rust diseases of wheat.

With the realisation that wheat varieties responsive to heavy fertilisation would be required in the coming years, Dr. Pal reoriented the wheat breeding programme. The result was the NP 800 series, which is both rust-resistant and responsive to fertilisation. In a joint paper with his colleagues presented at the International Genetics Symposium held in Japan in 1956, he showed that wheat varieties have two sets of genes related to rust resistance — one conferring rust resistance and the other inhibiting the resistance reaction, and that the extent of rust resistance in different crosses depends upon which set of genes is involved. Contrary to the view that hybrid vigour could be usefully exploited only in a cross-pollinated plant like maize, Dr. Pal showed that the situation holds good even for a self-pollinated crop like wheat.

Dr. Pal has been intensely interested in the application of research, and during his tenure the IARI saw a complete integration of its research, teaching and extension functions. Dr. Pal has been the recipient of numerous awards like Padma Shri (1958), Rafi Ahmed Kidwai Memorial Prize (1960), Birbal Sahni Medal (1962) and the Srinivasa Ramanujan Medal (1964).

●●

IMC Awards

The Indian Merchants' Chamber has announced its annual awards for technological research. The award winners are : Dr. P. C. Mahendru, Dr. D. C. Parashar, Dr. G. D. Sootha, Mr. Devendra Singh and Mr. Narendra Kumar of the National Physical Laboratory, New Delhi, for the development of an electrostatic photocopying machine ; Mr. Anil Chandra Chatterjee, Chief Chemist and Technologist of Walchandnagar Industries Ltd, Poona, for technological research in the manufacture of white sugar; and Mr. B. S. Bapat, Mr. A. B. Marathe and Mr. Ravindra Marathe for the development of an automatic speed changer and an automatic two-speed starter.

The Chamber's award for the best export performance goes to Indian Telephone Industries Ltd., Bangalore, for its exports of telecommunications equipment.

FICCI Awards

The Central Leather Research Institute, Madras, has won the Federation of Indian Chambers of Commerce and Industry (FICCI) award for scientific and technological research for 1971. The award is for the technical know-how developed at CLRI which has obtained 50 patents in leather technology.

Escorts, Delhi, a private firm, has bagged the FICCI award for agricultural promotion and Tata Exports, Bombay, for the highest exports of engineering goods. Escorts has been conducting soil tests, field surveys and demonstrations, land planning and development, and lectures on farming through the farmers' clubs it has set up at various centres.

Improved teaching aid

N. V. Gholba, Superintendent, Tasgaon High School, Sangli District, Maharashtra, has been awarded the second prize in the competition for improved teaching aids held by the National Council of Educational Research. The first prize has not been awarded.

Mr. Gholba wins the prize for his invention of " Light ' O Scope ", an apparatus to demonstrate a ray of light and several laws in optics such as rules of reflection, refraction, dispersion, deviation, etc and also certain optical characteristics. Mr. Gholba teaches methematics, science and geography.

IN THE FORTHCOMING ISSUES...

STRESS ON THE HUMAN BODY

SPACE SHUTTLES

THE NEW MATHEMATICS

SCIENCE FILMS

SCIENCE SHAPES LIFE

KILLING SORROW

Sickness can be of the mind. In which case surgery is not possible. Or rather, was not possible till the advent of surgery of the brain. Doctors have destroyed specific areas of the brain (like in pre-frontal lobotomy where the frontal lobes are severed from the rest of the brain) to relieve patients of perpetual anxiety or depression. But such surgery to relieve emotional disturbances is not all that popular as patients relieved of anxiety come out of the operation relieved of other symptoms of emotions as well. Now a Finnish neurosurgeon, Lauri V. Latinen of the University Central Hospital at Helsinki, has discovered that the destruction of a piece of brain tissue about the size of a pea can relieve anxiety and tension permanently. Of the 11 patients he operated on, only two relapsed — probably because the lesions were too small.

Latinen's is a delicate operation and is fortunately free of side-effects. He introduces a small electrode into the brain after local anaesthesia. High frequency stimulation is used to block the activity of small amounts of tissue till the patient suddenly feels relaxed. Then the tissue at the site is destroyed.

These lesions in all probability involve nerve fibres in the corpus callosum. This joins the frontal lobes to the cingate area which is involved in the neural basis of emotion. The operation, however, was not successful in three cases of depression. This suggests that anxiety and depression are separate diseases.

RULES FOR A HEALTHY HEART

No cigarettes, and not too much eating are the first two rules laid down by Dr. M. G. Karvonen, director of the Institute of Occupational Health, Helsinki, Sweden, if you want to have a healthy heart.

Four more rules for reducing the risk of coronary heart disease are:

— cut down on those foods, such as fat meats, sausages, salami, dairy fats and hardened margarine, that contain saturated fats;

— avoid eating egg yolk;

— favour a diet with lots of grains, fruit, vegetables fish, salad, cooking oils and soft margarine;

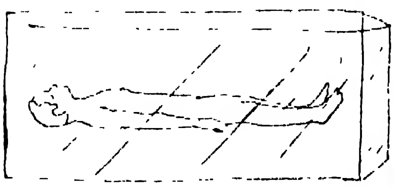
— and have your blood pressure checked at least once every five years.

Dr. Karvonen gives the rules in an article in *World Health*, the magazine of the World Health Organisation.

NUCLEAR POWER — 1977

In 1977, there will be an estimated 27 countries operating an estimated 319 nuclear reactors. At present there are 15 countries using nuclear power and 127 reactors are in operation. This is the breakdown of the future (1977). USA: 122 reactors (94,705 MW(e)), UK: 44 reactors (14,365 MW(e)), USSR: 31 reactors (10,469 MW (e)), Japan: 26 reactors (15,259 MW (e)), West Germany: 19 reactors (8,142 MW (e)), France: 11 reactors (2,933 MW (e)), Canada: 9 reactors (4,016 MW (e)), Sweden: 9 reactors (5,311 MW (e)), Spain: 8 reactors (3,573 MW (e)) and India (1980): 6 reactors (2,700 MW (e)). But it will be a long, long time before nuclear power will replace conventional methods. Like when the coal miners went on strike in England, the entire power supply system was paralysed.

BRINGING THE DEAD BACK TO LIFE



A latter-day Lazarus-type tale might just be in the making. Soviet researchers A. S. Konikova, A. V. Pagasova and V. I. Nikulin of A. V. Vishnevsky's Institute of Surgery, Moscow, have been experimenting on the possibility of bringing a dead person back to life. They experimented on rabbits, studying the molecular mechanism of death and using a type of heart-lung machine to trace the fate of protein synthesis after death. They found that cooling the body immediately after death increases " the possibility of body reanimation and the restoration of protein biosynthesis after death ".

They added radioactivity labelled lysine to the oxygenated blood of their machine to assess the capacity of the various bodily organs to synthesise proteins after death. By tracing the label at various times after death they were able to gauge the rate of loss of ability to synthesise proteins. It took the brain a mere five minutes to lose its ability. Most other organs were defunct within half an hour. That meant any attempt at reanimation should be carried out within 20 minutes of death.

The researchers felt the reason for a block in protein synthesis was not so much organ degeneration as the accumulation of substances which consequently prevented the uptake of amino-acids. Chilling, they felt, might be one way to arrest the accumulation. They have succeeded in revitalising all organs to synthesise protein (including, though to a lesser extent, the brain) an hour after death at 25°C. Biosynthesis, heartbeat, breathing and even motor responses were resumed.

"MAGIC" MOON ?

Reports have been appearing on the unexpected growth-promoting effect of moondust on plants, which have prompted people to infer that the lunar soil has a "magic" ingredient. But we are now back on earth with a recent report in the *Canadian Journal of Botany*. J. D. Weete of Houston's Lunar Science Institute and C. H. Wilkinshaw of the United States Department of Agriculture, NASA, cultured tobacco plant tissues in the presence of this dust. Sure enough there was a difference. The plants, grown over periods of up to 12 weeks, were much greener. But the greenness, they found on chemical analysis, came from a greater chlorophyll content (the light-trapping green pigment in plants concerned with photosynthesis). The tissues also contained higher levels of carotenoids than normal. These are accessory photosynthetic pigments.

They haven't yet traced the cause of this increase. But they deduce that the stimulatory substance is released from the Moon by a cation exchange process as a result of the acidity of the growing plant cells. Botanists will eagerly wait to know whether this substance is also a terrestrial substance, or a new combination of common materials, or an entirely new substance.

AUTOMATIC HELICOPTER LANDINGS

The first fully automatic landings by a fullscale manned helicopter at a predetermined spot were made last month by a team of research engineers and pilots of the National Aeronautics and Space Administration's Langley Research Center, Hampton, Virginia, USA.

The automatic landings were performed with laboratory-type equipment in a research environment to study performance requirements for automatic VTOL aircraft operations in all-weather, city-centre to city-centre service.

The landing approaches were fully automatic from a point 3·2 to 4·8 kilometres from the intended landing spot, and all landings were made within a couple of metres of each other. The automatic system was engaged in level flight at 96·5 kilometres per hour and 244 metres above the ground.

When the research helicopter, a CH-46 tandem rotor helicopter, intercepted the landing guidance path, the system automatically locked on to start the landing approach. At a predetermined range from the touchdown point, the helicopter began an automatic deceleration to zero ground speed, coming to a hover 15·2 metres over the landing spot. It then descended vertically to a touchdown.

Five approaches were made: three at a 6-degree descent angle; one at 10 degrees, and one at 15 degrees.

Guidance for the approaches and landings was provided by a ground-based GSN-5 tracking radar linked by telemetry to on-board equipment in the CH-46 helicopter. An analogue computer in the helicopter and a special Langley-developed inertial signal-smoothing device provided control signals to a four-axis electrical input servo control system.

THE SUDDEN DEATH OF THE SMOKER

If man is anything like a dog, he is in danger — at least the coronary patient who aggravates his condition by smoking cigarettes. The experts agree that cigarettes are dangerous — involving risks of long-term degenerative illnesses like cancer, bronchitis and heart disease. In fact, cigarette manufacturers in the UK and USA have to print warning labels on their products.

Now scientists have found that those suffering from heart diseases may be prone to sudden death if they smoke. S. Bellet and his colleagues at Philadelphia General Hospital, USA, have provided the experimental data to back up these epidemiological observations. They studied the ventricular fibrillation in dogs while administering cigarette smoke to them. Fibrillation, which is thought to be responsible for sudden death, is a fast, quivering heart beat and can be initiated or stopped with electric shocks.

Among the dogs used, some were healthy while others had myocardial infraction (this is a dead area of heart muscle, commonly the result of a coronary attack) induced through surgery. The fibrillations were induced by electric shocks on the chest wall or directly on the heart. The intensity of the shock was increased. At a threshold level, abnormal heart tracing appeared. This threshold level was lowered when the animals inhaled cigarette smoke. Both the normal and coronary dogs experienced a fall in the threshold level within two hours of smoking, the most susceptible time being 45 minutes after inhalation. While normal dogs themselves experience a 30 to 40 per cent drop in the level, the other dogs reached an extremely low level.

Could this mean the cigarette smoker has another reason to worry?

THE HANDICAP OF SLEEPY PEOPLE

Most everyone knows that a sleepless night has its after effects in performance at work the next day. But the 'why' of the fact has never been clearly deciphered. Till this report from Maryann Deaton, J. S. Tobias and R. T. Wilkinson of Cambridge, England. They show just how performance is affected in a simple decision-making task after a night without sleep.

They made their experimental subjects listen to two half-second

THE "NEVER-SAY-DIE" TYRE

The scene was the Paul Ricard motor-racing circuit at Le Casteliet, near Marseille, France. The event — a remarkable and unusual demonstration of a new wonder tyre. There were engineers and product planners and representatives from numerous car manufacturing companies. And they all watched intently as cars raced round the circuit. Not 'raced' exactly but 'speeded' along at a comfortable 80 kmph — *on two or three deflated tyres!* A Ford Capri suffered a blow-out at 160 kmph but continued on without even a momentary deflection from its straight course. A Ford Escort covered 160 km at a steady 80 kmph. Cars could take sharp corners without hazard with one or more tyres punctured.

With conventional tyres, such demonstrations would have been disastrous : a high-speed blow-out would involve a roll-over accident with maybe a few fatalities. A slower-speed puncture would result in the tyre twisting off its rim, damaging the rim and the tyre and giving an extremely bumpy ride. These difficulties with conventional tyres arise because a flat tyre becomes hot rapidly and distorts to the extent that the sidewall and often the metal rim scrape the road.

In the new tyre — christened the " total mobility " tyre — the heat problem is solved with a lubricant. Each tyre has 150 cu cm of liquid in one or two capsules. When crushed, on deflation of the tyre, the fluid spreads inside the tyre, separating the rubber surfaces inside and carrying away all the heat produced at speeds up to 80 kmph. At this speed the rubber surfaces slip with respect to each other at 6 m/second. The fluid seals any small punctures there may be and partly reinflates the tyre to a pressure of about 0.2 kg/sq cm. The distortion is solved by a redesign of the rim and a change in the shape of the tyre. The original tyres had a round profile but in recent years they have been squeezed in till the distance from rim to ground is just 70 to 80 per cent of the inflated width of the tyre. The new tyre has a very low 'profile ratio' — a mere 60 per cent — and a wider

Deflated tyre

tread and a rim narrowed to only 60 per cent of the tread width.

This, of course, makes for a less comfortable ride. But the ride quality is improved. The tyre costs one-third more than conventional tyres — but the cost might be balanced by the elimination of the spare wheel and jack. The quality of the drive is good enough for a driver to keep going on a deflated tyre for several days before visiting a garage. The rubber structure of this tyre is similar to existing tubeless tyres, so plugging a puncture would raise no problems. The costs rise because the old lubricant has to be cleaned out and new containers added — at least one and a half times more expensive.

These tyres cannot be fitted on to existing cars. But they should make their debut in the new generation of cars that roll off the assembly lines in 1974.

tones every two seconds for half an hour. Fifteen per cent of these tones were slightly shorter than the rest. The subjects were asked to detect these tones. They went through two such tests — one after a good night's sleep, the other after a night without sleep.

There were two notations made on each subject — the percentage of short signals detected and the number of times a short signal was reported in error. From these two figures, two further measures were obtained. The first of these related to the inherent sensitivity of the subject to data from the outside world about the decision he is to make. The second related to the decision-making process which he adopted.

The researchers found that lack of sleep resulted in a fall in sensitivity to data but did not change the decision-making process. That means lack of sleep affects people by reducing their discrimination of information on which they arrive at decisions, not by affecting the decisions themselves. So, though the faculties for decision-making are not impaired, it is the selection and transmission of information that goes haywire.

BUGGING THE MOTOR BUGGY

The pollution threat of carbon monoxide fumes from automobile exhausts has been bugging the world for long. But not for much longer it seems, if the findings of Reinhold Rasmussen and Robert Hutton are put to use.

Rasmussen and Hutton did a cooperative study on the atmosphere at the Isthmus of Panama. What they were interested in were the sources and sinks of the volatile organ compounds found in the air beneath the canopy of the tropical rain forest. They froze the water from the air and then examined the dissolved organic materials. And they were in for a surprise. They found the slightly " oily " water stimulated the growth of many fungal micro-organisms. They then speculated that fungi and maybe even algae, bacteria and yeast growing on leaves, banks or other surfaces of the jungle could utilise volatile organics in the atmosphere for carbon and energy sources to promote metabolism and growth.

If that is the case, why not use the organic gases of car exhausts?

They extended their hypothesis to this point. They refer to an unpublished report, coauthored by Hutton, which showed that tropical leaf litter reduced the hydrocarbons in dilute car exhaust gases. They also quote other papers which show that samples of soil microbes remove carbon dioxide, ethylene, sulphur dioxide and oxides of nitrogen from test atmospheres.

So the next time you drive out, give these little microbes a lift in your car exhaust — they'd give you and the world sterling cleaning service.

INCREASED STRENGTH BY STARTER MOLECULES

Ideal composite materials could be produced if cohesion between two materials could be achieved with the aid of their own intermolecular forces. Professor K. Hamann of the Research Institute for Pigments and Lacquers of Stuttgart University reported on studies of this kind at a conference of the Society of German Chemists recently held in Karlsruhe. He is primarily interested not merely in dyeing plastics by mixing the raw material with dyestuffs, but in obtaining thoroughly dyed products of absolute colour fastness. His trick is to make use of the fact that the long plastic molecule chains require a special starter molecule for their formation, which then remains chemically linked to the beginning of the chain. He therefore constructs suitable colour molecules in such a way that they are capable of functioning as starter molecules, firmly fixed as such in the plastics molecule. It may be possible, some day, by applying this principle, to use the entire surface of a material as a starter for plastic molecule chains.

AND NOW IT IS ANTIBIOTICS

Two years ago, a curb on the use of antibiotics in animal feed was implemented in the United Kingdom. And now similar action is being taken in the US by the Food and Drug Administration. Their reason revolves round the possibility that low-level use of such drugs in feed may be linked to establishing drug-resistant bacteria in man. The FDA also proposes to ban these drugs in human medicines. Unless drugmakers provide safety and efficacy data, the drugs that are stated for phase-out include tetracycline, streptomycin, dihydrostreptomycin, spectinomycin, neomycin, penicillins and sulphonamides.

THE IDEAL VILLAGE

It is called Fondaghat and it lies in Kankavali taluk of Ratnagiri district, Maharashtra. The Mahatma Gandhi Centenary Committee has chosen it as the ideal village in the competition it organised.

Here are a few statistics that probably influenced the choice: Fondaghat has 13 public wells, 3 pre-primary schools, 8 primary schools, a high school, a primary health centre and a library. On the agricultural front, the village has increased paddy production by 30 per cent. It has made similar progress in the fields of public health, water supply and road development. And, of course, in the social spectrum untouchability and illiteracy have been eradicated. The village is also free of liquor, gambling and disputes.

TREATING PSYCHIATRIC ILLNESS WITH HORMONES

Physical and psychoanalytic treatments for psychiatric illnesses have always been a controversial subject. Most psychiatrists feel both methods are needed though each school has its staunch adherents. Now two papers report on two aspects of physical treatment — one an old method, the other a new one.

The old method was rather drastic — brain surgery. Desmond Kelly, C. J. S. Walter, Nita Mitchell-Heggs and William Sargent did a follow-up study of 70 patients who had undergone leucotomy — the controversial operation that destroys areas of the prefrontal lobes of the brain. This operation is now done with cryoprobes or radioactive 'seeds' and not just by a direct cut. There was a noticeable improvement in almost all cases of depression and anxiety. There was also considerable improvement in obsessional neurosis, schizophrenia and personality disorders.

This is an old operation historically. A newer treatment is hormone treatment for sex offenders. Many drugs have been used and now Alan J. Cooper, A. A. A. Ismail, A. L. Phanjoo and D. Love have shown that a specific antiandrogen that antagonises male sex hormones without the side-effects of oestrogen therapy may be the drug of choice. This drug, cyproterone acetate, is just coming into trial use. The researchers experimented on three deviant and highly sexed patients. The physical manifestations of sexual arousal were significantly dampened (shown through low plasma testosterone levels) and sexual fantasies and tensions were also reduced.

The two papers will go a long way towards showing that physical treatment for psychiatric illness is necessary and its role will grow in years to come.

THE MINI-DISH

The Marconi Space and Defence Systems have been awarded a British Ministry of Defence (Navy) contract to develop a small shipborne satellite communications system (SCOT) to work through the British military Skynet system. The dish aerial, only 1.1 metre in diameter, will be the smallest ever used in satellite communications.

THE NOT-SO-SILENT SEA

A. A. KARANDE

Scientists are trying to listen to the various sounds coming from deep under the sea and know what they mean

BENEATH the serene silence of its surface, the sea seethes with life — and a bewildering range of strange sounds. From the snapping sound of the shrimp to the loud cracks of the whale, each marine creature speaks a language of its own. But hardly anyone had been listening. Or if somebody did, it was as an idle pastime or out of curiosity. But not any more. Today more and more scientists are listening to these underwater sounds. And the listening is fast developing into a sophisticated science.

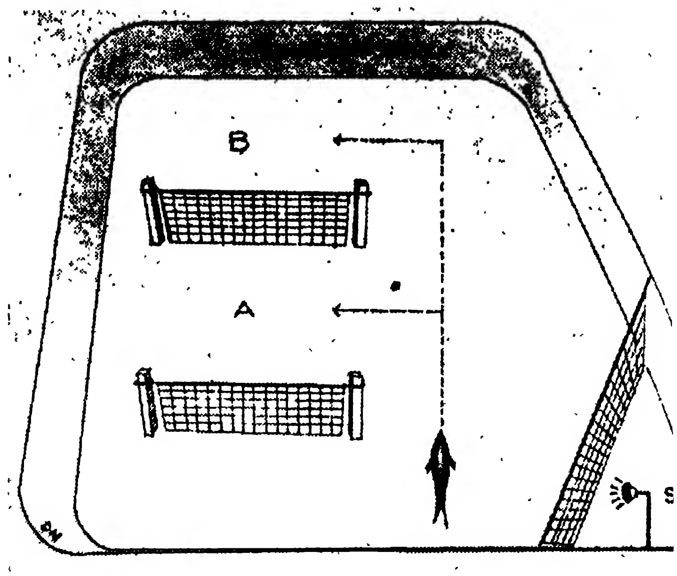
That too with a good reason. A large number of fishes and marine animals like dolphins and porpoises can make significantly loud sounds. The rest, though not sound-makers extraordinary, are responsive to these sounds; sound perception in fish is, in fact, a stronger faculty than sound production. With the growing interest in fisheries all over the world, these facts can be used in detecting large shoals of fish, in identifying them and in studying their movements and breeding habits. To the oceanographer, these can also be an aid in navigation. And since each fish makes its own distinct sound and is also sensitive to other sounds, sound can be patterned to attract or scare away a particular species. In fact, modern fishing methods in the US and Japan have been increasingly taking advantage of these facts (Fig. 1).

When marine organisms produce sounds, they may do it purposefully. Or they may produce them inadvertently, by striking some organ or a part against a hard substratum. This can also occur as a result of biological activities such as searching for food, feeding, swimming or fighting. The first variety — the deliberate sound-making — is called biological sound; the rest is all noise. A large number of marine organisms make more noise than sound.

Though underwater sounds are weak, they can be as varied as those heard on the land. The sound may be as silent as the "deep breath" of the shark or as loud as the "hooting boat whistle" of the toad fish. Or it may resemble the "put-put" single cylinder auto noise, or "dots and dashes" like the Morse code or the jingle of the "falling coins" or the "thud" a rat makes when it is trapped in a box. We are familiar only with the sounds made by shallow water fish like shrimps, prawns or croackers (some of these sounds can be heard even with unaided ears). But since most of the marine animals live deep under water, they are neither seen nor are their sounds heard. Not yet.

The loudest sounds are made by the drum fish (*Corvina umbra*), a bony fish, *Crenilabrus tinca*, and a toad fish, *Opsanus tau*. The white whale makes noise that can be heard in the air or through the hull of a ship. The sound spectrum of the various marine fishes and the mammals have been described by Schevilla. The sound of the "snapping shrimp" or alpheids ranges in frequency from about

Fig. 1: Hearing organs in fishes show a more advanced stage of development than the vocal organs. A fish can be trained to respond to sound from a transducer. For example, as illustrated here, the yellow fish in front of transducer (S) turns sharply between the nets (A) in response to sound but goes straight ahead (B) around the pool when sound is below the threshold limit. This behaviour helps in fisheries. Besides, in reservoir systems fishes are injured as they pass through turbines or over the dam spillways. It is now proposed to use sound for guiding the fishes downstream and thus avoid the loss. Sound can also be used for scaring away unwanted fish like baracuda and for luring commercial fish



500 cycles per second to 20,000 cycles, the approximate limit heard by the human ear. The rasping sound of the spiny lobster (*Panulirus argus*) ranges from 40 cycles to 9,000 cycles with the most common being at 600 cycles. Tuna produce sounds with lower frequencies by the sudden movement of the tail. The "knocks" made by the skipjack tuna has a frequency range of 400 cycles to 5,000 cycles with the maximum intensity lying between 500 and 700 cycles. Croakers (*Micropogan undulatus*) usually produce sounds at a frequency of 100 to 10,000 cycles.

These are normal sounds. At times they can rise, like when a fish courts. The noise of the courting male of the gobiid fish reaches a pressure of 0·1 to 0·2 dynes/cm², about 20 cm away from the hydrophone and that of the bleniid fish reaches about 0·5 to 0·8 dynes/cm². The difference in frequency peaks depend mainly on whether the sound comes from the intrinsic sonic muscles and the air bladder or from some bony surfaces stridulating over each other. Sounds made by sonic muscles lie below 4,400 cycles whereas those from stridulation lie below 10,000 cycles. In mammalians such as whales, dolphins and porpoises which make noise both under water and in the air, the sound range is very broad, from 30 cycles to about 200,000 cycles per second. But some of these sounds, being beyond the audible range, cannot be heard.

Sound-producing mechanisms

How are these sounds produced? First, the invertebrates. Barnacle, a sedentary crustacean, makes the noise by moving the body in relation to its shell. Where the number of the barnacles is high, the noise can be quite loud. Lobsters (some of the known sonic species are *Palinuridae vulgaris*, *P. argus*, *P. striatus*, *Linuparus trigonus* and *Justitia longimanus*) generally produce noise by rubbing the ridged membrane of the antenna against the toothed surface on

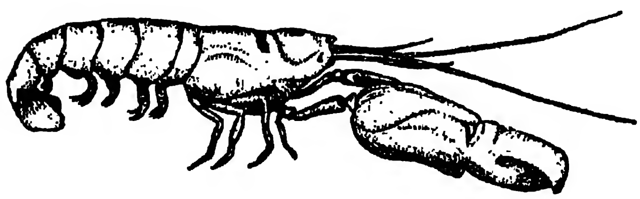
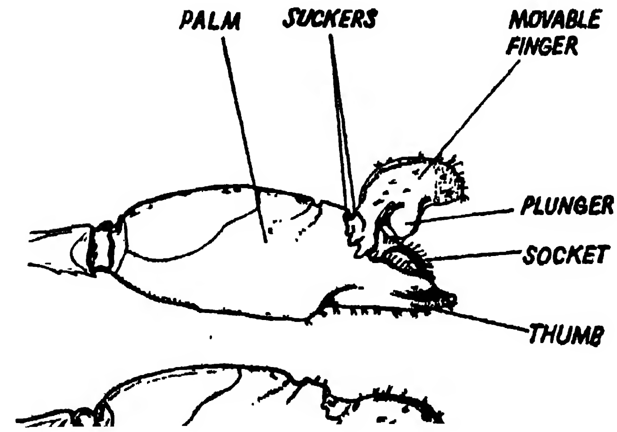
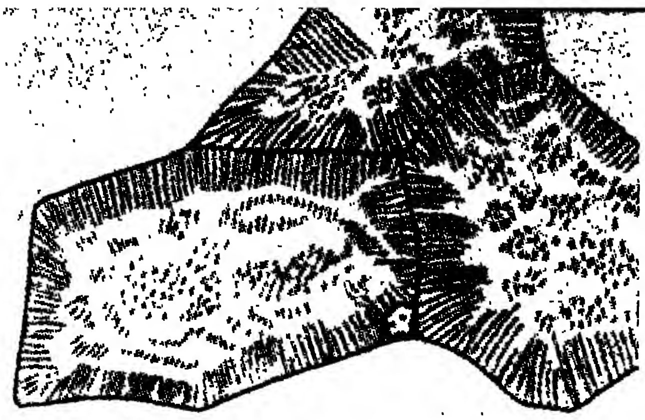


Fig. 2: (top) Pistol shrimps *(Crangon californiensis)* are called the gunmen of the tide pools. They possess a large appendage like a pistol hand, equipped with a snapping device which is used as a weapon of offence and defence. When it snaps in an aquarium, the sound can be heard outside. This shrimp which lives for about eight years in captivity gets its food by stunning its prey such as small fish as it passes over the entrance of its burrow. The fish is then dragged inside the burrow and the meal is shared with a partner

Below: A pistol shrimp with a snapping claw: (A) snapper open, (B) snapper closed

A.





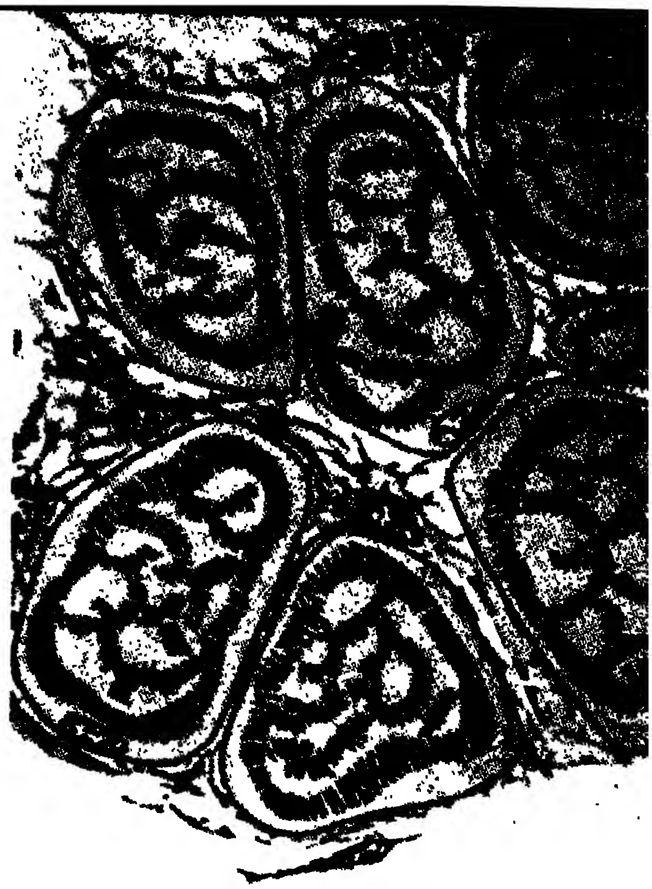


Fig. 3: A great number of fishes like cat fish, squirrel fish and tiger fish possess extrinsic muscles which together with the air bladder produce a variety of sounds. These drumming muscles are attached at one end to some part of the skeletal apparatus and at the other to the air bladder. Sonic muscles (right) are red in colour due to the presence of myoglobin which is an oxygen reservoir. These muscles are generally made up of thin cylindrical fibres whose diameter is usually only half that of other body muscles. Sonic muscles usually act slowly but are capable of prolonged activity while the pale non-sonic muscles act fast and fatigue quickly (above)

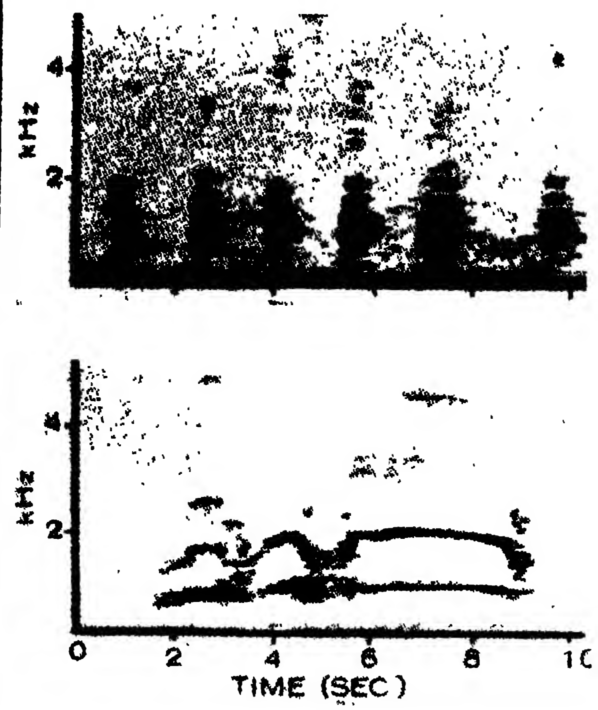
the shell of the head. Crabs produce noise by stridulating at sea. A green crab (*Carcinides maenas*) produces noise by "blowing bubbles" at the mouth in the inter-tidal zone. Noise made by the horse-shoe crab in captivity has been reported by Moulton.

Among those with stridulatory organs are a large number of shrimps. Alcock described a sound-producing species of shrimp near the Ganjam coast of India. Various species belonging to genus *Metapenaeopsis* produce noise by rubbing abdominal pleurons against the toothed ridge located on the posterior branchiostegite, a leaf-like appendage. Snapping shrimps make loud sizzling noise which can be easily heard under water or close above the surface. These shrimps use a snapping mechanism (Fig. 2) located in the largest chela in their limbs. Stomatopod shrimps (such as *Gonodactylus chragra, C. oerstedii* and *Pseudosquilla cliata*) also make noise with the help of raptorial appendages by striking two different parts of the appendage over each other, or by striking the whole appendage against some other object.

Fishes

Among fishes, the sound-producing mechanisms are far more varied than in the invertebrates, though the exact mechanisms in some deep water species are still not known. Fishes use various stridulating organs such as ridged teeth, dorsal fin spines, parts of the pectoral girdle and gills. The loudest sound, however, is made with the help of the swim bladder which is made to resonate with the help of the sonic muscles. These muscles, made up of thin fibres, are generally red, but the colour usually varies with the content of myoglobin (Fig. 3). In Zeida fishes, the air bladder contains a diaphragm. The opening of this bladder is surrounded by sphincter muscles (regulatory muscles). When the muscles contract, the diaphragm is set in motion, emitting sound which is made more intense by the vibratory motion of the gas.

Sounds in fishes like sharks come from their swimming activities. In file fish (*Monocanthus hispidus*) and puffer fish (*Lagocephalus scleratus*) the noise is created by stridulating ridged teeth. In species like *Balistes vetule* and *Melichthys piceus*, the air bladder is in intimate contact with the skin in the pectoral (chest) region, and the sound is created by the rapid beating of the pectoral fins against the air bladder. In this class of trigger fishes (*Balistidae*), noise is also generated by grating teeth, dorsal fin spines and by stridulating the pectoral girdle. In gobiid fish (*Bathygobius soporatur*) and in bleniid, (*Chasmodes bosquianus*) the jet-like escape of water from the gill area creates noise. The grunt-like noise of *haemulidae* is made



Almost all the orders of marine mammals have been observed to be vocal with the exception of sea otter (*Enhydra*). Vocalisation appears to be associated with social organisation. The California sea-lion (*Zallophus*) produces sounds under water in conjunction with feeding, echolocation and breeding aggregation. The Atlantic bottlenose dolphins produce a sound with a whistling pattern with slight variations, yet each animal has individual "signature" of its own. The intensities of sounds produced by the northern elephant-seal (*Mirounga*) have been recorded. The recorded sound can be divided into two main groups: threatening sounds (top) and attraction signals (above)

with the pharyngeal teeth; it is then amplified by the resonating air bladder close to the stridulating teeth.

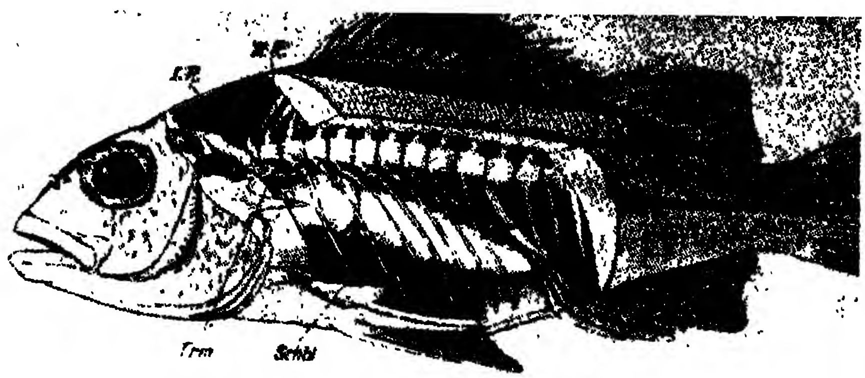
The sound-producing mechanisms in deep sea fishes have been studied by Marshall. The benthopelagic fishes (750 species, swimming near the bottom) possess a gas-filled swim bladder. The sharks, chimaeras and alepocephalids, however, have no swim bladder. They make the noise by stridulating their tooth plates. Though many mesopelagic fishes have swim bladders, they are not equipped with drumming muscles. Benthic fishes that habitually stay at the bottom of the sea are generally silent.

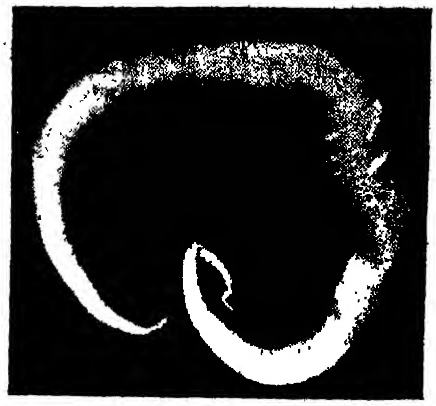
Mammals

Now the marine mammals. Of some 112 species, sounds of at least 40 species have been recorded and analysed. Walrus, dolphins, *Stenella* (a cetacean) and pilot whale (*Globicephala*) are some of the best studied mammals. Mammals produce a variety of sounds such as squeals, sharp clicks or loud cracks. Perhaps this group has a language of its own. Cladwell who worked on bottleneck dolphins found that each animal he studied had an individual "signature". However, the organs involved in mammalian sound are not as varied as those of fishes. Vocal chords are missing in mammals but there are projections and thin membranous parts in the laryngeal cartilages which may vibrate when the air passes through the larynx.

What are the factors in the marine environment that influence the acoustic behaviour of the various organisms? There are several, like crowding, visibility, temperature, local or extensive migrations. These affect both the quality and the quantity of the sound. Schneider who experimented on tiger fish (Fig. 4) observed that the ambient temperature or illumination influenced sound production in this fish species. Under controlled conditions, he observed that at 30°C the sound production was higher. At 33°C, the activity diminished. In general, colder temperatures inhibit sound production. Tiger fish responds to light stimulation instantly; in dim light (luminance $0{\cdot}32$ and $0{\cdot}55 \times 10^{-2}$ asb) almost like the first twilight, the number of drumming sounds and particularly threatening sounds increased markedly. Most of these factors are probably related to the feeding and breeding habits of fishes.

That shows that underwater sounds have much functional significance. Based on these, the sounds can be broadly divided into 5 categories: communicative, echolocation, feeding, defensive or offensive, and insignificant. The sounds not only help in keeping fish schools together (Fig. 5) but facilitate the propagation of the species. Sound can signal sexual urge in a fish and its readiness to mate; it can thus help in bringing the opposite sexes together, in courtship and in mating as they do in cod fishes or toad fishes. A cetacean, *Tursiops*, makes peculiar sounds in the mating season. Among crustaceans, the fiddler crab makes a drumming sound at the time of mating. Outside the spawning season, cod fishes may make threatening sounds when they are in danger. Adult





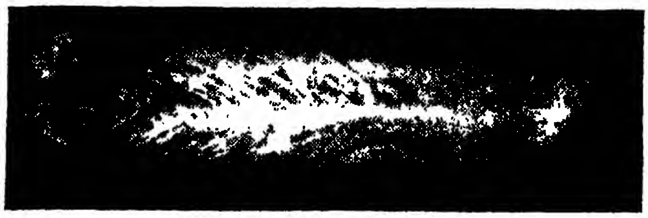


Fig. 4 (above): Sound-producing mechanism of a tiger fish. Sonic muscles (Trm) located below the first and the second rib (I R, II R), resonate the gas in the air bladder (Schbl) to produce the noise. Right: The shape and size of the air bladder vary with the species of the fishes

cods may make grunt-like sounds which scare away the younger fishes and thus help to disperse them more widely over the feeding grounds. Pacific bottlenose dolphins display a "scouting" behaviour when confronted with a barrier across their direction of movement. A leader gives several vocal signals before the group passes through the barrier.

The sea-lion (*Zallophus californianus*) and the elephant-seal (*Mirounga angustirostris*) use sound in the parental care of their young ones. The female elephant-seal keeps in touch with her pups giving long harmonic calls.

Like bats, fishes often use sound for echolocation — an important tool in locating objects and impediments in the way and in finding the depth. The fish judges the depth or the location of an object by the echoes coming off the object or the sea bed. Slope-dwelling sonic fishes maintain their orientation by this method. And probably the same mechanism lies behind the efficient manoeuvring of the cave-dwelling fishes. That would also explain how sea-lions are able to detect objects even when visibility is poor. Pinnepeds make a wide variety of vocal and impulsive calls, believed to be part of a sophisticated system of echolocation. Work reported on porpoises shows that the echolocation system in these animals can work in very noisy conditions.

Fig. 5: Sound in fishes is a means of maintaining the integrity of a school

Acoustical biology or biohydroacoustics is a fast developing branch of oceanology. If we can understand the significance of the sounds made by commercial fishes, we can study their migrations, population densities, size patterns and maturity — all vital to fisheries. For this, sounds of marine animals from different regions have been already classified and published. Moulton had surveyed sounds of squirrel fish and grouper fish in the Bikini Island area. Runnstrom and Cushing have done the echo-survey of herrings in the Norwegian and English waters. Hylen used similar methods to determine the distribution of cod fish in Barents sea. But the new science needs a coordinated effort where sound engineers, instrument engineers, physiologists, animal behaviourists and navigators work together in recording and analysing the sounds, understanding their significance, relating it to fish behaviour, etc. In India, we have yet to make a beginning.

The Mystery Disease from South India

K. S. MANI

One of these days a bit of human brain tissue inoculated into a chimpanzee may help medical researchers say whether a slow virus is behind this baffling nervous disease that has shown up in South India

AT first there was hardly any clue. Patients would come to the Government General Hospital at Madras complaining of stiffness and pain in the lower limbs; many had difficulty in free movement. And most of them were young adults, of both sexes. The doctors had known the problem had something to do with the spinal cord. But laboratory facilities were so inadequate that another decade passed before the author and his colleagues could take up any serious study on this baffling disease

Initially it was known as South Indian Paraplegia, mainly because it had not been described elsewhere. Neither the patients nor their relatives knew when it began. They became aware of it only when walking became difficult, particularly while moving over stairs or on uneven ground, where the feet tended to drag. The muscles around the hip and the knee — in fact, most of the lower limbs — were either weak or stiff, making movement difficult. However, there was no total paralysis, nor any major impairment in the upper limbs, except that the fingers in the hands at times lost finer movement. The sensory side had a few problems too, like numbness, tingling, "pins and needles" and/or burning sensation in the feet and hands. The more advanced cases had urinary difficulties — either difficult passage of urine or loss of bladder control. And constipation in the bowels. A few exceptional cases had convulsions too, indicating that the brain might have been affected.

The disease remained a mystery. In the broad spectrum, the nervous system has two categories — the central, comprising of the brain and the spinal cord and the peripheral which comprises all the peripheral nerves. The spinal cord could be compared to a huge bundle of cables which transmit information, *via* relay stations in between, from the limbs and trunks upwards to the brain and commands from the brain to the muscles of the limbs and trunk.

The nerves from the lower limbs join the spinal cord at lower levels, while those in the trunk and upper limbs do so at successively higher levels. Thus, damage to the lower portion of the cord would affect the legs, while damage to the upper spinal cord would affect the legs, trunk and arms. The spinal cord also has nerves to the bowels and urinary bladder, hence the constipation and difficulty in urinating seen in patients.

The spinal cord also serves as a feedback mechanism. It conveys signals from the muscles and joints, enabling the brain to activate the required muscles without under or overshooting. There are two main sensory conducting systems in the spinal cord, one (the spinothalmic column) conveying sensations of pain and temperature and the other (the posterior column) conducting proprioceptive impulses (or appreciation of the self in relation to the external world).

Obviously, complete damage to the spinal cord would result in total loss of movement, sensation and bowel and bladder control. This is known as paraplegia. There are several diseases of the spinal cord. Some are rapid and cause total paralysis in a matter of minutes. Others are slow and insidious. The effects vary with the part of the cord affected and the speed of onset. The patient may fully or partially recover and have one or two relapses. More than one disease of the spinal cord can produce the same changes in the same part of the body, but the type of onset, the course of the disease, recovery and follow-up information provide useful clues as to the basic type of the disease.

The spinal cord is covered with a tough membrane or envelope which in turn is enclosed in the bony spinal canal. The metabolic demand of the cord is so much that it is impossible to provide more than just enough blood supply. Thus the margin of safety as far as the blood supply to the cord is concerned is very narrow indeed. No part of the body could ever be considered in isolation. They all work together in a harmonious manner, but this could be very easily upset by disease. The blood vessels to the spinal cord, for example, could be blocked by certain disease processes, with a resultant catastrophic damage to the cord. A fracture dislocation of the spinal column could cause crush injury or even complete section of the spinal cord. Tumours could press on the spinal cord or even grow from within. Very little is known about the essential nutrient requirements of the central nervous system and when the diet is not adequate or is not properly balanced or is absorbed poorly, there could be involvement of certain pathways of the spinal cord. And there are some diseases in which certain parts of the brain or spinal cord degenerate, possibly due to the lack of certain enzyme systems; often these deficiencies are genetic and tend to run in families.

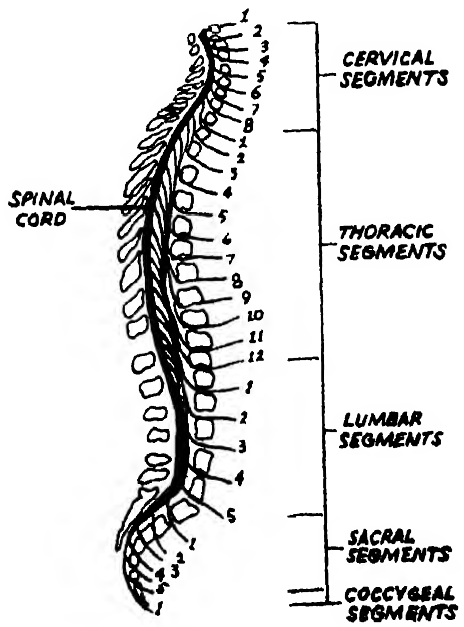
When medical researchers come up with what appears to be a new disease, they go into the patient's history, conduct examinations and follow-ups, and rule out known disorders. They conduct a detailed post-mortem in fatal cases, which may yield clues about the cause. However, the mysterious South Indian paraplegia refused to yield any clue. Despite over 200 examinations made on 45 patients, the cause remained elusive. The patients did not have more anaemia (as shown by haemoglobin estimations, levels of vitamin B_{12} and foliates) than other paraplegics of known causes. And tumours on the spinal cord were ruled out by X-rays of the spine, lungs and examination of the spinal fluid.

New diseases

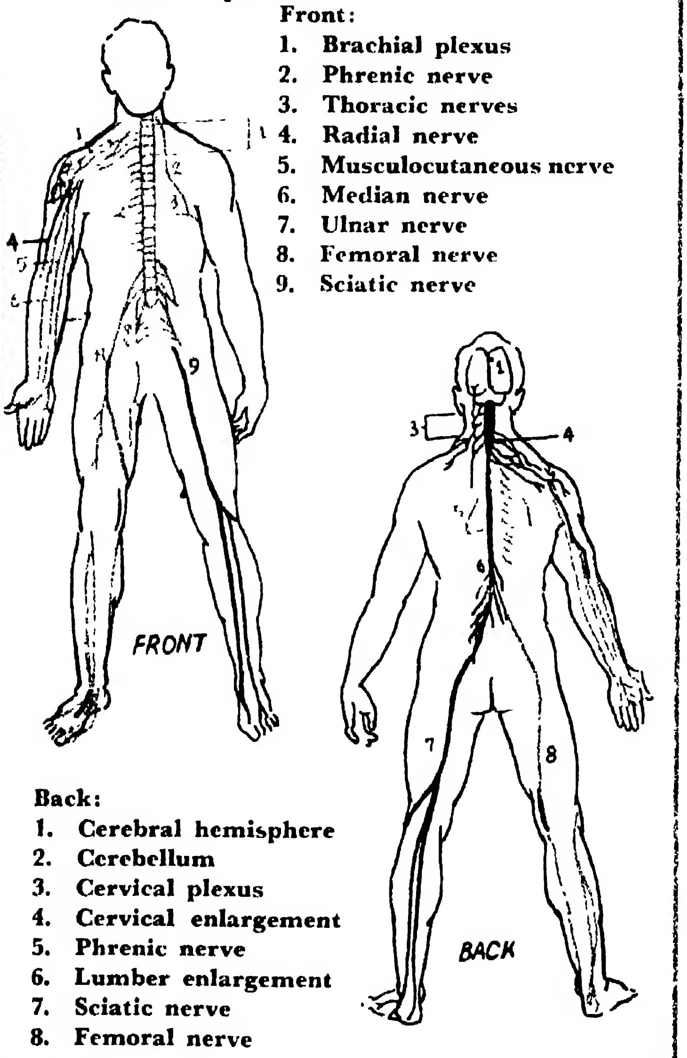
No drugs were able to influence the course of the disease, though they might have given some relief of the symptoms. The patients were followed up for periods ranging from 6 months to 8 years, most of them for more than three years. Of the 45 patients, 39 per cent showed no change, 24 per cent became worse, another 24 per cent died, and 13 per cent improved slightly. The single detailed post-mortem examination available showed a picture quite different from any of the known disorders affecting the nervous system. The blood vessels of the brain and spinal cord are thickened, with a resultant reduced blood supply to these regions. In the spinal cord the areas starved of blood supply are mainly the areas which control voluntary and skilled movements, the bladder and bowels and the proprioceptive sense, which explains the related symptoms. The post-mortem examination, however, does not suggest that the disease was caused by some toxic chemical — such as are used in insecticides, pesticides and various drugs — acting on the nervous system. Clinical features and investigations do not suggest a primary nutritional disorder affecting the nervous system.

However, it is quite on the cards that the disease is similar to, if not identical with, a

Spinal nerves (side view)



The Peripheral Nervous System



disease called Jamaican neuropathy, described recently from Jamaica in West Indies, because the details, including the autopsy findings, are similar. That is why the name Tropical Spastic Paraplegia has been proposed for this illness.

We have a hunch that the disorder might be caused by a slow virus. Most people think of a virus infection of the nervous system as a raging illness that wrecks a man beyond repair in a matter of hours. A bright and lively child can become an idiot in hours following a virus infection, for nerve cells are so specialised that damaged or diseased ones are just not replaced and the patient either dies or is put out of action mentally.

But that's not how all nerve viruses do business. Some — the "slow viruses"— take their own time, as has become clear in the last two decades. They are called "slow" because, having achieved a state of biological co-existence with the human host, they stealthily and slowly sabotage the nervous system, particularly the brain and spinal cord. Veterinary researchers have known for long that slow viruses produce neurological disorders in sheep. They could even reproduce the diseases in healthy sheep by inoculating their brains with brain material from diseased sheep; the disease was found to appear within months of such inoculation.

The first evidence that a slow virus was the cause of a nervous degenerative disease, called Kuru, came from the cannibalistic Fore tribe of the forests of Eastern New Guinea (north of Australia). Since the disease used to occur in several families it was at first thought to be hereditary. But it was shown that the Kuru disease could be produced in chimpanzees inoculated with brain material from Kuru victims, after removing the non-virus particles. So the disease was an acquired one. Then it came to light that when the Fore tribe feasted on human beings, it was the women and children who ate the brains of the victims, the men considering it beneath their dignity to eat this part. And it was the women and children who developed the disease years after such a meal. Today with more effective control of cannibalism, Kuru is a fast disappearing disease in the area.

Inoculation of chimpanzees with brain material has shown that another so-called degenerative disorder of the brain is due to a slow virus, though it is not clear how the slow virus enters a patient. We are now trying to take a tiny bit of brain material from living paraplegia patients, and send it, transported in dry ice, to a pioneering laboratory carrying out work on slow viruses. Here the brain material will be inoculated into chimpanzees which will have to be watched for several months before any results could be expected. Our single post-mortem examination and the series from Jamaica suggest a possible infection by a slow virus, but more studies will be required to confirm this.

That will not be all. How the infection is carried from one human being to another — whether by mosquitoes or other insects — will be another tangle for the researchers to sort out. Only when we are able to pinpoint the cause of the disease can we devise measures to prevent it.

ROUND-UP OF RESEARCH

MINERALOGY

Metals in Oceans

WHEN the non-ferrous metals in the land masses of the world are fully exploited, mankind may turn to the oceans for more. Metals like nickel, cobalt and copper compose the nodules found on the floors of the Atlantic, Indian and Pacific oceans and with the advances in oceanographic methods, increasing deposits of these nodules are being discovered. Dr. D. S. Cronan of the Department of Geology, University of Ottawa, Ontario, Canada, has now in a report in *Nature Physical Science* (*235*, 171, 28 February 1972) presented new analytical data for Mn, Fe, Ni, Co and Cu in 152 Atlantic nodules and compared them with data on samples from the Indian and Pacific oceans.

Nodules are rounded concretionary bodies which can be separated as discrete masses from the formations in which they occur. They are probably formed by the precipitation of salts from the oceans on to a small nucleus, such as a piece of stone. They are black in appearance because of their high manganese content. Concentrations of nodules vary, but deposits of about 11,000 tonnes a square kilometre are known to exist in some parts of the Pacific.

There are significant differences in the average composition of the nodules from the three oceans. The chief constituent of nodules are manganese, iron and silicon and those from the Atlantic have a Mn/Fe ratio of less than unity, whereas those in the Pacific and Indian oceans have a ratio greater than one. Among minor elements, the average compositions of nickel in the nodules of the Atlantic, Indian and Pacific oceans are estimated as 0·30 per cent, 0·50 per cent and 0·70 per cent respectively, of Co as 0·31 per cent, 0·28 per cent and 0·38 per cent and of Cu 0·11 per cent, 0·22 per cent and 0·37 per cent.

For any undersea mining venture to succeed economically, the deposits will have to be carefully mapped for both concentration and mineral content before mining starts. Probably, a radioactive irradiation and analyses procedure carried out on the sea floor may eventually provide accurate metal concentration maps of the nodule beds.

DRUGS

Oral Therapy in Diabetics

DIABETES mellitus is a disease of metabolism in which processes concerned with the formation and utilisation of carbohydrates in the body are disturbed. An outstanding feature is the deficient supply of insulin, a hormone produced by the pancreas.

Tablet or oral therapy for mild diabetes came into general use in 1956, and tolbutamide was one of the first drugs to be used. Since then other compounds in the sulphonylurea group and biguanides like phenformin have been introduced. At first oral therapy was used only in those diabetic patients who could not be placed on simple dietary restrictions. Tablets, however, are now being used more and more widely as long-term treatment. Nevertheless, there is some evidence, though disputed, that oral therapy increases the mortality rate from coronary thrombosis in long-standing diabetes.

Drs. A. M. Tomkins and A. Boom belonging to Whittington Hospital, London, have now in a study (*British Medical Journal*, *1*, 649, 11 March 1972) determined to what extent long-term continuous tablet treatment is necessary in maintaining diabetic control. Their study was conducted on 64 diabetic patients attending the hospital clinic, who had been maintained on oral therapy since they had failed to respond to diet alone when first diagnosed. The patients were given placebos and observed until relapse of diabetes occurred or for a

minimum period of 6 months. The results indicated that 43 patients (69 per cent) relapsed within 6 months while the blood sugar control remained unchanged in 19(31 per cent) for a period up to 10 months. All the patients who relapsed responded when the previous therapy with drugs was reintroduced.

The British doctors conclude that since 31 per cent of the patients they studied remained as well controlled even after oral therapy was discontinued, this suggests that even when the need for oral therapy had been established by a poor initial response to simple dietary restriction, the introduction of tablets should not be regarded as permanent. When a relapse of diabetes occurs, it is advisable to reintroduce tablet therapy at the previous effective dose level.

ANTIBIOTICS

How Penicillin Acts

THE antibiotic penicillin kills bacteria by inactivating two key enzymes involved in the production of the sacculus, a cage-like structure at the bacterial cell wall, according to three German scientists, Drs. R. Hartmann, J. V. Holtje and U. Schwarz of the Friedrich-Miescher Laboratorium of the Max Planck Institute. The details as to how they characterised and purified these two enzymes in *Escherichia coli* are reported in *Nature* (*235*,426, 25 February 1972).

By 1957 it had been established that the lethal action of penicillin is due to its selective inhibition of the biosynthesis of bacterial cell walls. The cell wall of a bacterium, the sacculus, gives it a certain freedom over the osmotic stresses of its environment. Without a sacculus too much water would enter the bacterium causing it to swell to bursting point. The molecular structure of the sacculus is complex. It can be regarded as partly composed of a single macromolecule of enormous size known as murein. The backbone of this polymer is made up of chains of an aminopolysaccharide (polymerised sugar molecules) composed of alternate residues of N-acetylglucosamine and N-acetylmuramic acid. The residues of N-acetylmuramic acid are linked to short strands of polymerised amino-acids (polypeptides) and the latter cross-linked to one another by means of inter-peptide bridges to give the sacculus its net-like structure and rigidity.

The growth of a bacterium is accompanied by a continuous expansion of the sacculus. It has been suggested before that the growth of the sacculus is a two-step process. In the first, certain points of the macromolecule murein are ruptured by enzymes, and in the second new building blocks are added to the growing sacculus at the ruptured points. The structural modifications of a sacculus during cell growth are accomplished only when the murein degrading enzymes—murein hydrolases—provide acceptor sites for incoming new material at the right place, at the right time, and in the right order and amount.

In their experiments, Dr. Hartmann and his colleagues used the degradation of the high molecular weight sacculi into small reaction products to assay murein hydrolase activity. They developed for this a sensitive test system using radioactively labelled sacculi. After disintegration of *E. coli* cells, hydrolase activity was detected in both the particulate and soluble fractions. It was found that penicillin inhibits the enzyme endopeptidase in the particulate fraction and the enzyme glycosidase in the soluble fraction. The scientists point out that though both endopeptidase and glycosidase were assayed as hydrolases, or rupturing enzymes, it is quite possible that these enzymes are also involved in the proper positioning of the new material in the growing sacculus. But whatever their exact role, they are undoubtedly key enzymes in the biosynthesis of the structural elements of the bacterial cell wall.

Both endopeptidase and glycosidase accept as substrates the polymer murein which forms the sacculus. The structure of penicillin closely resembles N-acetylmuramic acid and, hence, it acts by competing with the two key enzymes for this murein sub-unit, thus blocking their activity. The physiological effect of penicillin on *E. coli* is, hence, explained as due to the irreversible inhibition of the reactions by which the cross-linked peptides are formed, the last step is the synthesis of the cell wall murein.

Schwarz, Asmus and Frank have reported before (*J. Mol. Biol*, *41*,419, 1969) that penicillin has two distinct morphological effects on *E. coli*. Cell division is blocked at a concentration higher than 20 units/ml whereas cell growth is increasingly affected only at concentrations which are higher than 100

units/ml. The concentration of penicillin that blocks endopeptidase activity is now found to be roughly the same as that preventing cell division, and the glycosidase is blocked by the sort of concentrations that stop cell growth. Hence, Drs. Hartmann, Holtje and Schwarz suggest that endopeptidase is primarily involved in cell division and glycocidase in cell growth.

PLANETARY ATMOSPHERE

Venus Clouds

VENUS is the second planet from the Sun at a mean distance of about 108,000,000 km from it. Named after the Roman goddess of love, it is one of the most conspicuous objects in the sky and is frequently referred to as the 'morning star' or the 'evening star'. One of the prominent features of the ultraviolet photographs taken from the Earth is its clouds. In spite of many successful penetrations of the atmosphere of Venus by the Soviet Venera space probes and by the American Mariner spacecraft, the question of the composition of the clouds of Venus, however, remains controversial.

Dr. Bruce Hapke of the Department of Earth and Planetary Sciences, University of Pittsburgh, Pennsylvania, USA, now argues in *Science* (*175,748*, 18 February 1972) that any proposed substances constituting the clouds must be consistent with the extremely strong evidence concerning the physical nature of the cloud particles derived from the spectral and polarisation data of Venus. The spectrum of radiation from Venus shows that the cloud particles absorb strongly in the near infrared. Absorption features are also observed in the visible and in the ultraviolet region. The polarisation data indicate that the particles are spherical and, hence, are almost certainly liquid. They have a narrow range of sizes, with radii close to 1 micron.

Among the many materials that have been suggested as the dominant component of the clouds are H_2O liquid or ice, partially hydrated ferrous chloride, ammonium chloride, mercury halides, carbon suboxide and dust. Dr. Hapke has shown that the evidence for the physical nature of the cloud particles as well as the spectra rule out most of these proposed substances as the major constituent of the clouds.

The only gases in the atmosphere of Venus that have been detected spectroscopically from the Earth are CO_2, H_2O, CO, HCl and HF. Venera probes have measured a predominant CO_2 composition. The American physicist argues that the temperature profile of the atmosphere of Venus obtained from Mariner spacecrafts and the narrow size distribution of particles imply the presence of a condensing component like water in the clouds. The absorption features in the near infrared can be accounted for if OH_3 + ions—hydronium ions—caused by the addition of HCl to water are abundant in the clouds. The infrared spectrum of HCl also appears to be compatible with the observed spectrum of Venus.

If the crust of Venus is similar to the crusts of the Earth and the Moon, due to volcanic activity, ions of Si, Al, Ca, Fe, Mg, Na, K and Ti and smaller amounts of Cr, Mn and V should be found as solid nuclei and in solution in the clouds of Venus. Now, the coloration of terrestrial and lunar rocks and minerals is due almost entirely to absorption features associated with the elements Fe, Ti, Cr, Mn V with Fe being by far the most important, because of its geochemical abundance. Dr. Hapke, hence, estimates that ferric iron (Fe^{3+}) and complexes of iron formed with HCl should account for the observed spectrum of Venus in the near ultraviolet region and for the yellow colour of the clouds of Venus.

To the eye the disc of Venus is featureless, but when the planet is observed in the ultraviolet, large diffuse markings which persist for several days or weeks become visible. According to Dr. Hapke these ultraviolet features could arise from variations in the concentrations of iron and hydrochloric acid in the cloud particles.

He concludes that the spectral and polarisation data for Venus are consistent with micrometer-sized cloud particles of HCl with soluble and insoluble iron compounds, whose source could be volcanic or crustal dust. Further, he suggests more high precision observations of Venus in the near ultraviolet and infrared to confirm the presence of Fe, HCl and liquid H_2O in the clouds of Venus and to indicate their abundances.

K. A. Neelakantan

BLURS & BRIGHT SPOTS

Leave the drugs and let them die!

DOES a human being have the right to make his own private peace with death? Especially when he is terminally ill? Like being told when he is likely to die? Or like refusing a treatment because he finds it pointless to prolong his life by a mere couple of months? If you accept a person's right to die with dignity, the answer would be, yes. But then the Hippocratic oath doesn't let you say, yes; as a doctor, your duty is preservation of life — at whatever cost. What would you do?

The question has been bobbing up in the minds of physicians for quite some time, but has rarely been put to a serious test. Now, it seems, they may not be able to bypass the answer much longer. Not after the little drama in a Milwaukee hospital in the USA last February.

According to a report in the *New Scientist*, Gertrude Raasch, a 77 year old widow, had been operated twice for hardening of the arteries. The second time, her left leg was amputated below the knee. But her condition worsened and her doctors suggested a third operation — this time amputation above the knee — which would let her live a few months longer; otherwise, she was likely to die in a few days. The patient refused to sign her consent. Then the hospital authorities approached the courts to appoint a guardian for the purpose of obtaining legal sanction. The judge came to the patient's bedside. But after he had heard her, he decided the old lady really had no desire for another surgery and ruled that she should be allowed to " depart in God's own peace ".

The Milwaukee incident is no isolated case. All through the medical profession, death and dying is a subject of growing concern. In fact, the subject has already been elevated to a scientific discipline under the title 'Thanatology ' (from *thanatos*, the Greek word for death). In the USA the pioneer thanatologist is Dr. Austin Kutcher, a professor of dentistry at Columbia University, who had come to the subject five years back after his wife's death from cancer. He had found the grief unbearable and his colleagues found no published guidance about how to help those who watch their loved ones die. Something had to be done to fill the void. Kutcher and three colleagues formed the Foundation of Thanatology in New York — an institute where the dying process could be studied in all aspects.

Now, several other groups have raised the banner. The Euthanasia Society, for instance. Also, medical colleges are beginning to include courses on treating the dying. There are entire seminars devoted to thanatology alone. This upsurge of interest is due to a paradox: the enormous success of modern medicine in postponing death.

But is the postponement always necessary? thanatologists ask. The lingering days mean nothing to the patient, who is most of the time comatose from being drugged and needle-pricked and betubed and sedated. "It has come to be a pretty ugly business." Thanatologists seek to remove some of the ugliness, to let the terminal patients pass away with dignity.

But doctors do not find it easy to give what thanatologists ask for. How much do you tell a terminal patient about his illness? How much do you tell his relatives? A study by a UCLA psychiatrist, Dr. Herman Feifel, indicates more than 80 per cent of the seriously ill wish to know the full extent of their illness; yet anywhere between 70 and 90 per cent of physicians are against telling a patient that his illness is probably terminal.

The other point of the controversy concerns the use of drugs to relieve pain in the dying. Thanatologists insist the drug and the dose should be so chosen as to leave the patient mentally alert and physically capable. However, one proven way of doing this — oral administration of heroin — is not feasible because the law does not permit possession or prescription of heroin. Another promising research concerns the use of psychedelic drugs like LSD and a chemical relative known as DPT. Work at the Maryland Psychiatric Research Centre at Baltimore, USA, has shown highly positive results.

(Continued on page 27)

The Future of Computers in India

P. JAYANT

The annual convention of the Computer Society of India held in Bombay this year was significant from various points of view. The foreign aid situation and the Government policy on foreign-owned company operations in India had left the question of IBM's future in India under suspense for a long time. It was time computer users in India knew what to expect. The following thoughts from a participant echoes, we are assured, the feelings of a large number of business users

ONE year ago, the Electronics Commission was set up under the chairmanship of Prof. M. G. K. Menon. Industrial and business users of computers have been waiting very patiently for major policy decisions from the Commission—decisions that were to influence the entire future of the use of computers in India. Hope, therefore, ran high when Prof. Menon himself was chosen to inaugurate the Annual Conference of the Society. The other significant fact was that the Electronics Corporation of India Ltd, which was set up by the Government a few years ago, had started putting on the market small-size computers.

The bone of contention of course lay elsewhere. The licence given to IBM by the Government for renovating and assembling computers in India was coming to a close. The other firm ICL, which had agreed to manufacture its computers with Indian participation, still had a licence to produce another 50 small-size computers in the 1901 A series. In the last four years since announcing the IBM 360 in India, IBM had booked nearly 60 customers who have been anxiously waiting for the delivery. Further, in some cases, companies in both private and public sectors had reached full utilisation of the capacity installed and yet did not see any possibility of getting additional capacity in the near future, since the IBM 360 manufacture had still not been approved by the Government of India. Meanwhile, just one week before Prof. Menon was about to inaugurate the Conference, IBM had sent out letters to all the prospective users of the 360 system informing them that they would be unable to supply the IBM 360 system from their Indian plant because of the Government's indecision in this matter.

That was the background. Naturally, the audience which assembled at the Bhabha Auditorium on Sunday 12 March 1972 had come with high hopes of knowing the Electronics Commission's mind. Prof. Menon's inaugural address referred to the history of the development of computers in India and paid rich tribute to the work done at the TIFR and other centres in developing computers with indigenous know-how. He referred to the frustrations amongst the users of computers in India to which the President of the Society Col. Balasubramaniam had earlier referred and assured that the Commission would do everything possible to provide to the workers in the field of computers the type of equipment which was required for the future. He grouped the requirements for computers into three areas: (*a*) for scientific applications; (*b*) for commercial needs of individual large organisations; and (*c*) commercial needs of the smaller organisations.

The Electronics Commission, he said, had already started laying down policies for the manufacture and use of computers in this country. Starting off with the simplest equipment in terms of electronic desk calculators, the Commission had already decided on a policy that these would be manufactured strictly with Indian know-how and by companies with Indian management. In the light of the fact that today the IBM and ICL computers are being assembled and not manufactured in India, he said, the policy regarding the manufacture of computers in the country will follow the same lines as have been laid down by the Government for foreign-owned companies. This was a reference to the new policy statement of the Government in which it has been indicated that companies having foreign holdings would be allowed manufacturing in the country only for 100 per cent export. This

meant the IBM which is a fully American-owned company would not be able to assemble any IBM 360 system in this country except for export.

Prof. Menon said the need for large computers for scientific work will have to be fulfilled by installing large systems of the type available at the TIFR. As by and large the computers required at universities and research laboratories were just to make the students and young researchers familiar with the apparatus, the smaller computers which will be manufactured by the Electronics Corporation of India Ltd. (ECIL) could as well fill the bill. This will mean learning the language of these new computers and struggling to develop the software for some time to come. But he said scientists should be willing to do this remembering that when no computers were available in India, a person of the stature of Dr. G. N. Ramchandran of Madras University learnt the language of the TIFRAC computer and used it to solve his problems and publish important scientific papers. He also suggested the establishment of regional centres at Bombay, Delhi, Calcutta, Madras, Bangalore and Kanpur where large computer systems could be installed so that several small industrial users could share the facility on a cooperative basis. By and large, he said, software should be developed mostly within the country barring a few exceptions where such software was of a highly specialised nature. He ruled out foreign participation in computer manufactures for supplying computers within the country and said that foreign participation could be allowed only in exceptional circumstances such as when the manufacturer was willing to bring in new technologies into the country and balance the inflow and outflow of foreign exchange.

A foretaste of frustration

By the end of the inaugural session, it was obvious that those who had hoped to get the IBM 360 system in the next few years would have to learn to live without them, with no possibility of getting even the additional 1401 since the IBM licence for even this outdated system would lapse in April. The only computers available for business companies would be the 1901As of ICL and larger computers when the regional centres come up in the next few years.

That the business users were disappointed with the policy enunciated in the inaugural speech was obvious on the next day of the Conference when Mr. Sharu Rangnekar delivered one of the two key-note addresses spelling out the challenges before the business and industrial users of computers in the next few years. He criticised the fact that the Electronics Commission was making decisions as to what was good for the needs of business and industry without ever consulting a single individual from the business users. He wondered whether the new technocrats were taking on the role of the old Indian Civil Servants and regarded themselves as omniscient. He expressed his dismay at the fact that the Electronics Commission had taken only one decision about the manufacture of desk calculators in its one year of existence. The idea of having several regional centres was ridiculous, he said, because if several users were expected to use a common computer by making use of terminals installed in their offices, they would be compelled to use much larger computers than was necessary for them and would thus be paying very dearly. He also pointed out that it was wrong to believe that industrial users were developing applications such as pay-roll or invoices on the computer merely to cut down the cost of massive data processing. Information obtained from these applications formed a part of the wider data-base required for more sophisticated applications in the areas of manpower planning, demand forecasting, production planning or distribution planning.

The Computer Society is a mixture of academicians, research workers and business users of computers. There are those interested in the hardware aspects, some purely in the mathematical problem-solving aspects, others in the teaching of computer sciences and still others in the use of computers in business and industrial system applications. But never was the divergence of views between the business users and the scientific users as sharply defined as in this convention. The business users were highly critical of the fact that the research institutes had been allowed by the policy-makers several large and modern computer systems while the industry was starving of minimum computer capacity. Besides, the industrial users claim, the research centres leave much to be desired in their management of computer centres especially because there is no participation of the users in the management of these centres nor any attempt to understand their difficulties. The business users also felt the training available in universities and institutes of technology or management needed to be application-oriented. It was also felt that the Society should take active interest in setting standards for the educational courses in programming and systems analysis being conducted by private organisations which it was felt had led to a lot

of dissatisfaction among the young graduates who had undergone these courses and had found them of very little value in improving their job prospects.

The proposal for developing time-shared regional computer centres raised the question of the quality and reliability of the communication channels available in India. These are at present regarded as unsatisfactory even for normal telephone and telex traffic. As to how the P & T would make them successfully available for transmitting data which would need near 100 per cent error-free operations was a question to which no satisfactory answer was available. Again the proposal to popularise the mini-computers of the TDC-16 or the TDC-32 type proposed to be manufactured by ECIL raised the question of manufacturing peripheral equipment like card-readers and printers. It was felt that the question of manufacturing tape and disc drives in India also had not been given deep consideration or at least the thinking on it had not been shared with the computer users by the policy-makers.

What can be done?

There are several steps which could be taken in developing a computer policy for the future:

1. The Electronics Commission could give recognition to the professionals concerned with various aspects of the development of computers in India such as hardware manufacture, software development, information systems in business and industry or teaching computer sciences by inviting the representatives of their professional body (viz the Computer Society) to share their thinking and to join in the policy developing effort. This could result in a two-way communication instead of the one-way communication which has existed so far.

2. The Electronics Commission needs to reassess in consultation with business users the expected demand for in-house computers of this group during the 1970s. Individual companies would find the use of large regional centre computers economic and effective only if their own size was too small to justify a small size in-house data processing facility or if the in-house computer is too small for handling large mathematical problems. But 90-95 per cent of the computer need is for developing information systems and only 5 to 10 per cent for mathematical decision-making applications; it would not be possible to use them in day-to-day practice and improve the decision-making processes in industry if the company does not have up-to-date information required by them.

3. It would be wrong to estimate the potential demand for computers on the basis of orders placed with IBM or ICL, first because with the rentals charged by IBM or ICL at present, many companies are likely to hesitate getting a computer whereas the rentals could be much lower if the total number of computers manufactured in the country were much higher. For example, if the ICL produces 150 computers of the 1901A type instead of the licensed 50 to 60, the rental could be lower by as much as 30 to 40 per cent. And the point to consider is whether there would be demand for 150 at that rental. Secondly, the awareness for computer-based information systems in decision-making is growing exponentially and not linearly all over the world. Thus if 150 computers have been installed in the last decade, we may expect the next 150 computers to be installed in the next 5 years and another 150 in the next $2\frac{1}{2}$ years. This is of course on the assumption that such a large number of small size computers can be made available at the expected rate of demand.

4. It is undeniable that India should manufacture computers within the country. But the Electronics Commission needs to make a realistic evaluation of what size of computers can be made in India, by which year and with what proportion of indigenous components. Today, in India, IBM and ICL mostly renovate and reassemble computers returned by first or second users abroad. ICL uses perhaps 30 to 40 per cent of indigenous components in its 1901A manufacture. It is not known what proposals IBM and ICL have for the manufacture of their more recent series in India and to what extent the components required for the manufacture of IBM's 360 or 370 series or for ICL's 1903A series are available today or what proportion of the components could be manufactured with concerted effort within India by 1976 or 1977. Availability of components is likely to be the major bottleneck in the quick development of a computer industry in India.

There are many smallscale manufacturers who claim that they can make any component required, but the ability to manufacture has to be matched by a consistent quality and reliability of products. It also means supplying the items in the large numbers in which they will be required by specified time schedules. The Electronics Commission would have to play an active part in co-ordinating the manufacture

of such items to ensure that computer manufacture started indigenously on an ambitious basis does not become uneconomic or that the delay involved by poor planning does not cause suffering to the potential users.

Manufacture of computer systems does not mean merely the manufacture of CPUs. ECIL can produce CPUs with 16K or 32K memory but line printers, card-readers, magnetic tape drives and disc drives are beyond the scope of ECIL at present. Even if plans are made to manufacture these in collaboration with smaller European countries, it will take three to five years by the time these peripherals are manufactured in India with 100 per cent local components. During the period 1972-75, however, these peripherals will either have to be imported or assembled by renovating equipment returned abroad. Thus a complete policy statement must include a clear plan for the manufacture of all the peripheral equipment besides that of the CPUs.

5. The problem of in-house small size computers for business and industrial users is somewhat acute because the number needed is likely to be large (two to three hundred in the next 6 to 8 years), and these will not be in the mini-computer range planned to be manufactured by ECIL. If they are in the ECIL product range, ECIL would have to undertake a much larger programme than it has at present. Besides, a correspondingly large support-programme for the manufacture of a range of peripherals will have to be set afoot from the scratch immediately. This appears to be beyond the present capacity of ECIL or of any new fully Indian or planned collaboration company.

6. If the use of computers in business and industry is not to be allowed to get a set-back during the next 3 to 5 years, it will be essential to allow ICL to manufacture more of their 1901A series or persuade them to produce 150 to 200 more of their 1903A series along with the necessary peripherals by 1977-78. Since ICL is a 50: 50 Indian-British collaboration, the new policy would imply that ICL would have to be able to export computers, peripherals or punching/verifying and accounting machines of the same value as marketed by them in India.

7. The large computer systems to be installed in research institutes and regional centres could also be of ICL manufacture. But this would mean playing into the hands of ICL by giving it the near monopoly of the computer market —just what IBM possesses in many parts of the world. From this point of view, it may be better to bring in other computer manufacturers such as CDC or Univac into this country by installing at least 8 to 10 of their larger systems in different centres. To facilitate stand-by facilities to the users, the regional centre and the research institute in each of the four metropolitan cities could be given parallel systems obtained from the same manufacturer in the same series, as far as possible.

8. There is no need to link up the proportion of foreign-equity with the proportion of production a company must export as long as there is no drain of foreign exchange. It is not known under what conditions IBM was allowed to start renovating the 1401 systems in India, nor is it known as to how much of its profit, IBM has repatriated in foreign exchange to USA. There is no reason why the 100 per cent foreign ownership of IBM should matter in allowing it to market its computers in India, if IBM agrees to two conditions:

(*a*) earn as much foreign exchange as it needs for importing components and technical know-how plus for repatriating profits, and

(*b*) start manufacture of their 360 or 370 system with the minimum possible lead time and of any subsequent models within one year of their announcement in the USA.

[Mr. Jayant, Manager, Management Services of Air India, is Secretary of the Bombay Chapter of the Computer Society of India. Formerly he was Secretary of the Operations Research Society.]

Blurs & Bright Spots *(Contd. from page 23)*

To die with dignity and grace! It seems strange that the living should be concerned with the manner in which they die. Yet, in the past year alone, the Euthanasia Educational Fund in the USA had about 50,000 "living wills" signed — documents which claim for the signer the right to die with dignity. Another American crusader, Dr. William Poe, of Duke University, is actually asking for special institutions — kind of " dying-in-hospitals " — where " a person could die in dignity without all the pother death engenders elsewhere . . . [It would be] an excellent place for surgeons to study some of the results of their art. Bodies that live more by doctor's reflexes than by their own are fit subjects for the study of the meaning of life! "

FIRE! FIRE!

K. PRABHAKAR NAIR

APRIL and May are the cruellest months, as far as fires are concerned. Partly because of the high temperature, partly because of the water shortage, fires are frequent in these two months. The causes, however, could be several. In the home, it could be the segree or a stove burst. For neither is there any rule nor any standard to check the design and the strength of the oil pressure stoves sold in the market. Often, defective stoves burst, causing a fire. Careless handling of the stove, like pumping it till the oil leaks and then lighting it or leaning over it with loose clothes can also be dangerous (see p. 38).

Another common incident is a spark from an electrical short-circuit, caused by worn-out or exposed wires, defective wiring or by overloading the domestic circuit; too often the circuit is tapped for too many domestic appliances. Or it may be an open lamp or careless handling of appliances like the electric iron, heater, etc or a gas leak in the kitchen. The burning cigarette butt or the matchstick that you so carelessly throw may set fire to a rubbish heap, or, playing with a matchstick, your child may burn the carpet. It is only a question of time before the fire then feeds on carpets, curtains and wooden structures. Statistics are not available for India, but such careless acts cause frequent fires all over the world. Look at these figures: cigarettes have set off 8,809 fires in New York, 5,595 in Los Angeles, 1,300 in Tokyo, 1,266 in Hong Kong and 706 in Montreal. In London alone, children playing with matches caused 4,276 fires.

Fires cause an annual loss of Rs. 15 crores in property in India. The cost in life is not known. Nor are the heavier indirect losses that follow — loss of production, cost of injuries, rehabilitation, etc. Yet, the general attitude to fire accidents seems to be: No, not in my place. Care is cast to the winds, and finally when the fire occurs it is too late (see box).

More serious are the fires that occur in factories and chemical plants. They also pose greater problems to firemen. Careless smoking, flames, welding or mechanical sparks, gas or dust explosions, static electricity, faulty processes — all these can lead to a fire. In Bombay alone, 40 factory fires broke out in the last two years.

In a fire, it is not the solid or the liquid that burns, but the vapours or gases released when they get heated. Fire risks run high in petrochemical plants using volatile and inflammable liquids like hexane, pentane, petroleum, naphtha, alcohols, acetone, etc. So also are processes which produce explosive gases such as hydrogen, methane, carbon disulphide and carbon monoxide. Hydrogen, particularly, has a wide explosive range — from 4 per cent to 74 per cent of it in air. Particular care, therefore, is needed in the vegetable ghee plants where hydrogen is produced by electrolysis; the resultant hydrogen and oxygen should be stored separately. Methane has an explosive range of 5 to 15 per cent in air. An open flame or a spark from faulty and unguarded electrical fittings can ignite these gases. And once this happens, the flames flash through the plant since the gas is present all over. One way of avoiding such accidents is to fill the electrical enclosures with inert gas or clean air. But this creates some designing problems. A more efficient way would be to use flame traps on the electrical installations. In case of an explosion, the flame traps, being good heat exchangers, will cool any escaping flames and thus contain the explosion. And since the trap lets the gas pass through, there is no sharp rise in pressure inside either. This obviously has

certain advantages over the traditional method of covering the fittings with a casing strong enough to contain the explosion. Some other processes where fire hazards exist are paint manufacture, cotton ginning and cloth curing in textile mills, spectacle frame and bangle manufacture using nitrocellulose sheets, etc. In all such cases, combustible raw materials should be stored separately out of contact with other materials or in a cool atmosphere (see box on p. 30).

Dust explosions

Occasionally, there could be a dust explosion. Combustible materials like carbon dust, cotton fluff, sulphur dust, etc can at a particular point burst into flames when ignited. And the finer the dust particles, the greater is the hazard. Dust is also produced in grinding processes or in flour mills. But it should not be allowed to settle into thick layers. A dust cloud large enough to explode is also sometimes kicked up by a water jet during fire-fighting. This was the case in a sulphur fire in a Bombay factory a few years ago; the water jet threw up a lot of dust which exploded into a secondary fire. Depriving the dust of sufficient atmospheric oxygen by circulating carbon dioxide or any other inert gas may prevent ignition. The air has an oxygen content of 21 per cent. But coal dust accumulation may not be safe in an atmosphere beyond 16 per cent oxygen content, cotton dust beyond 15 per cent, cork, hard rubber dust, etc beyond 13 to 14 per cent and sulphur beyond 11 per cent.

Such dust collections and concentrations of explosive gases and fumes can also generate static electricity, a major and frequent source of fires in factories. Static electricity is produced by friction, by the movement of materials, like when a bag of flour is emptied or dropped on the floor or when powders are mixed, ground or blown about. Electric charges also build up when you pour a non-conducting liquid from one vessel to another or even stir it hard, or when a conveyor belt moves over a pulley. For instance, when you unload a tanker into a storage vessel it can produce an electric charge of about 2,000 volts on the nozzle! This energy may well give a spark that can set aflame the vapours in the containers. When the material or the liquid is a good conductor, it carries the charge safely away and avoids an energy build-up. If not, and if the material is also inflammable, a fire can easily occur.

When there is a likelihood of static electricity, it is led off to the ground by several methods.

An extinguisher for the home

This is a domestic dry chemical fire extinguisher developed by the Industrial Design Centre of the Indian Institute of Technology, Bombay. The main feature of the extinguisher is that it is light — less than a kilogram in weight. The unit is made of a plastic, polycarbonate, and has three parts — the carbon dioxide cartridge, the dry chemical container and a partition. It is operated by pressing the knob at the top. The extinguisher is effective against all types of fire and has a greater fire-quelling capacity for the same volume. The manufacturing cost is estimated at about Rs. 35.

. . . and some hints

A little care at home may go a long way in avoiding fires and serious accidents. Here are some hints:

Don't bend over the stove, segree or any other heating appliance. Your clothes may catch fire. And don't wear loose clothes, or nylon clothes while cooking. Nylon sticks to the skin when on fire.

When using gas, never strike a matchstick or even switch on the light if there is gas leakage. Light the matchstick first and then open the valve of the cylinder and the hot-plate. After use, close both the hot-plate valve and the cylinder valve to avoid leakage. Naked light of any form should not be used while the gas cylinder is being replaced or repaired.

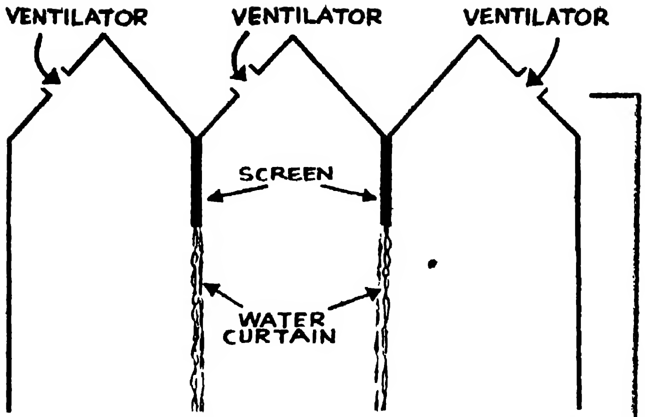
In case of fire, close the valve first and then put out the fire. If this is not possible, let the gas burn. Check the valves of the cylinder and the hot-plate before going to bed. This is important.

In Factories....

FIRES cannot be eliminated altogether in factories and chemical plants, but the risk and the damages can be minimised if certain precautions are taken. Some such measures were suggested by S. M. Desai of the Bombay Fire Brigade at a recent seminar held in Bombay by the Institution of Fire Engineers, Western India Branch.

Combustible raw materials, stored carelessly, are the source of many fires. Such raw materials should be stored separately. For example, metals such as sodium, megnesium which react with water should be stored in places free from water. Auto-oxidising agents such as vegetable oils should be stored in well-ventilated low stacks.

Structural materials spread the fire. In fire-prone areas, such materials should be fire-resistant such as steel. Areas within the factory should be divided by fire-resistant walls and doors. In cases where the process demands open doors, they should be held open using fusible links so that in a fire the links burn and the door closes. And when division is not possible because of a continuous process like that in a rubber factory, the alternatives are ventilators to avoid smoke-logging, screens from the roofs and water curtains (water is made to trickle off the screens to the floor to form a curtain, see sketch) to confine the fire and enable firemen get nearer to the source. Vertical shafts, openings in the floor for belting, internal stairs, freight elevators, trolley tracts and conveyor channels, etc which spread the fire should be enclosed in fire-resistant doors or water curtains.



Since flames can leap across some distance, various units in petrochemical plants should be spaced out to provide fire breaks. Besides, once fire breaks out, the heat builds up and propagates fast, making it difficult for anyone to work in the surrounding area. A heat radiation of about 4,000 BTU (British Thermal Unit) hour sq ft will burn the skin badly. So control valves, main switches, cable lines, even water hydrants should be fixed beyond this zone which can be calculated knowing the source, the likely flame height and temperature.

Safe exits are essential. There should be two escape routes, in opposite directions — each within eight metres (25 ft) in a storied building handling inflammables and 25 metres (75 ft instead of the 150 ft ISI standard) otherwise. The entire route from the place of work to the door, the corridors leading to the staircases and the staircases should be progressively wider and should be free of barriers, combustible materials, smoke, hot gates, etc. If possible, staircases should be enclosed. Industries with high fire risks should have sprinklers. Liquefied petroleum gas tanks, oil farms, transformers, etc should be protected with fixed sprinkler installations.

The most common is to bond and ground the materials. Where non-conducting solids are involved, it may help to increase the relative humidity. This will increase the amount of water film on the solids, which, with dissolved impurities, can conduct the charge away. The method has been tried in some finishing and coating operations. Other methods include the ionisation of the atmosphere by high voltage eliminators, by inductive ionisation using grounded bristle and tinsel bars, by enlarging the pipe section in a liquid flow to dissipate the charge or by increasing the conductivity through additives.

Have you watched the sparks flying while welding? These sparks have caused many fires in factories. Unless the vessel or tank to be welded is cleaned and made inert, the welding flame may give rise to chemical fumes and explosion. The flame can also ignite any fumes or gases or set alight any combustible materials around. This, in fact, has been the case in several accidents. Yet, often welding is done without proper care by untrained men.

Can we prevent these accidents? The Factories Act lays down that fire-prone processes and sources of ignition should be well enclosed and that dust, explosive gases or fumes should not be allowed to accumulate. It also prohibits welding, brazing, soldering or metal-cutting unless precautions are taken. But are the rules and safeguards adequate? Fire engineers do not think so, considering the increasing number of chemical and industrial plants and their complexities. The Act hasn't coped with these developments. It doesn't cover faulty processes and the means of handling and storing combustible materials. In any case, the Act is concerned mainly with the safety of the workers in case of a fire and not with the prevention of fire itself. It ensures the provision of safe means of escape — enough exits which

open outwards, two staircases where 20 or more persons are working on the upper floors, 10 metres being the minimum distance to a staircase if inflammable materials are involved and 50 metres otherwise. The emphasis, however, is now shifting towards fire prevention, and the Government of India is planning to introduce many new provisions for safe processes, particularly in solvent extraction plants. Maharashtra has already introduced such rules.

In any fire, the first few minutes are crucial. A flame or a spark, if not put out, continues to burn, feeding on the combustible materials around, and builds up a temperature of about 500°C in about 10 to 15 minutes. During this phase, the fire can be put out easily without much effort. Beyond this, the fire develops rapidly, and depending on the type of structural materials around, may continue to burn for about an hour or two. Then it subsides, having consumed all available combustibles around. This is the case in many fires except when large quantities of inflammable materials like petrol or kerosene are present. Any fire extinguishers or other means of putting out the fire, therefore, should be easily available within the first few minutes.

Are they? Here again opinions differ. There is no rule as far as the Factories Act is concerned. The Indian Standards Institute norms, which the factories generally follow, say there should be one extinguisher of the right type every 100 sq metres. But fire engineers think that this is not adequate. To be handy, an extinguisher should be available within about six to seven metres. The jet from an ordinary extinguisher reaches a maximum of about eight metres. Unless operated well, it is difficult to aim it at a fire from such a distance. Besides, one has also to take into account the rate of discharge of the spray. Experiments show that a developing fire needs a " critical rate " of 0·25 to 0·32 gallon of water per second or other extinguishers to suppress it. With a discharge of two gallons over 35 seconds (about 0·06 gallon/second), the usual 2-gallon extinguisher hardly meets the need. We would then need four extinguishers.

When there is a fire, many believe, that all one has to do is aim a water hose at the fire. But this is not so. Suppose you pour water on a petrol or kerosene fire, the water, being heavier, will cause the oil to spill over, spreading the fire. Or if you hold a water jet at an electrical fire, the water, being a good conductor, may

Extinguishers are for use !

THE extinguisher manufacturer was trying to help the customer in installing the equipment. The customer wanted it to be fixed about three metres high on the wall in his shop. The manufacturer pointed out that it would be difficult to reach it in an emergency. " Well, it will never be used," insisted the customer. So the extinguisher was fixed 3·5 metres high on the wall, where an average man will find it difficult to lift it up and use . . . when a fire finally breaks out.

That is the general attitude to fire precaution measures. And extinguishers are just a necessary formality to obtain the factory inspector's approval. Most of the extinguishers are so placed that they are not easily accessible in an emergency. Nor are they properly maintained or the employees trained to use them. And when the hour comes, the extinguisher doesn't work, either because the discharge nozzle is blocked, or the gas has leaked.

Extinguishers are of several types — water, foam, carbon dioxide, dry chemical. The most common one uses water as extinguisher and carbon dioxide to expel it. The oldest type is based on the reaction of sodium bicarbonate solution (soda-acid) and sulphuric acid kept in separate containers. On use, the reaction produces carbon dioxide which then expels the solution. Unless maintained well, the high temperature raises the vapour pressure and the sodium bicarbonate forms a scum on the discharge nozzle. The latter versions contain water and a carbon dioxide cartridge to expel the water. In carbon dioxide extinguishers, the gas is held in liquid form under pressure in containers. On breaking the container, the liquid turns to gas. Such extinguishers should be checked periodically for leakage, for at times the container valves are not properly fitted. Such a check for carbon dioxide leakage is also necessary for dry chemical extinguishers where the gas cartridge is used to expel the powder.

There have been many cases where people didn't know how to operate the extinguishers in a fire. Often, it is simply thrown at the fire. It is not enough to keep an extinguisher, people should be trained to use it. It may, after all, pay to ask the manufacturers to demonstrate how to use their equipment. But only a few do so now.

Multi-storey buildings and twin theatres

ON the night of 14 January this year, the 15th floor of the 21-storey State Bank Building in Bombay caught fire. Feeding on wood panellings, furniture and the false ceiling, the fire spread to the 16th, 17th and the 19th floors. The Fire Brigade had to struggle hard for a long time before it brought the fire under control — after five lives and about Rs. 1 crore worth of property were lost. The fire had to be fought from inside the smoke-filled structure. The 15th floor was over 50 metres high. In the worst of such accidents, 133 people were killed in a blaze that followed propane gas explosion in a 22-storied hotel in Seoul last year.

The State Bank fire highlighted the new problem cities like Bombay are facing. Skyscrapers are springing up everywhere. In any big fire, people should be evacuated within 2-1/2 minutes (after the fire is notified) because by then smoke would fill the building, causing suffocation and death. Quick evacuation is not practicable in multi-storied buildings and the fire must be fought from inside. The longest turn-table ladder with the fire service can reach only about 40 metres. Some of the floors are beyond the reach of the present equipment.

It is therefore more important to prevent fires and their spread in these structures. This needs certain provisions in the design and structure and some fire protection methods. In 1965, a committee recommended that such buildings should have two well-separated, fire-resistant or enclosed staircases, fire-resistant walls, doors and lifts, a wet riser (a water pump running to the top with two outlets on every floor), an underground water tank to feed the wet risers, booster pumps, etc. It should also have a fireman's lift to be operated by firemen only with all controls within it. Firemen think that in addition decorative laminations should be avoided as they spread the fire.

Making materials resist fire . . .

Wood burns in a fire, though thick sections delay the process. Steel looses its tensile strength and collapses at a 'critical' temperature of about 550°C. But these structural materials can be made to resist or slow down the process of burning, using fire-retardant paints or by impregnating wood. The most efficient is the intumescent paint. In a fire, the paint produces a thick carbonaceous cellular blanket on the substrate of the material. This method has been found effective for timber, plywood, hardboard, etc, and particularly for steel. An intumescent paint for wood has now been developed in India by the Central Buildings Research Institute, Roorkee, UP, and is also marketed by some private paint manufacturers.

A new method under detailed study in England is the water-cooled steel structure which retards fire. The structure uses steel beams and columns with hollow sections filled with water and interconnected. Water is circulated from an overhead tank. In a test, the steel structure withstood fire for 75 minutes when the temperature became constant.

form a circuit to give you a shock. For fire-fighting, firemen, therefore, divide all fires into five classes, depending on the nature of the source. Class A includes all water-quenched, carbonaceous materials like wood, paper, textiles, etc. In Class B are inflammable liquids such as petrol, benzene, oils, varnishes, etc where water, as explained, will not be of much help. What is needed is a vapour-forming liquid which, floating on the oil, cuts it off from oxygen supply. Foam and dry chemical powders serve this purpose. Foam is a protein-based compound, produced by the hydrolysis of slaughter house wastes such as hooves, horns etc. This is then agitated mechanically in the presence of air. Such foams are not efficient against alcohols and acetone since they dissolve in water. Attempts so far to make alcohol-resistant foams have failed.

Dry chemical powder is being increasingly used these days. It is manufactured by mixing talcum powder (or aluminium, calcium or magnesium stearate) with sodium bicarbonate and then adding fine pieces of asbestos to it. On expulsion from the container by gas pressure, the powder forms a screen over the fire, but the exact mechanism of how it kills the fire is not yet certain. The powder screen has another advantage; it allows the operator to reach quite near to the fire. The US Navy

These measures have not yet been included in the building by-laws. It is now said that they will soon be. Several skyscrapers that have come up in the meanwhile do not meet these standards. One of the provisions when the city engineer approves a building plan is that it should have adequate fire protection measures. But by the time the plan reaches the Fire Brigade for approval, the construction is usually halfway through, and it is then too late to alter the plans.

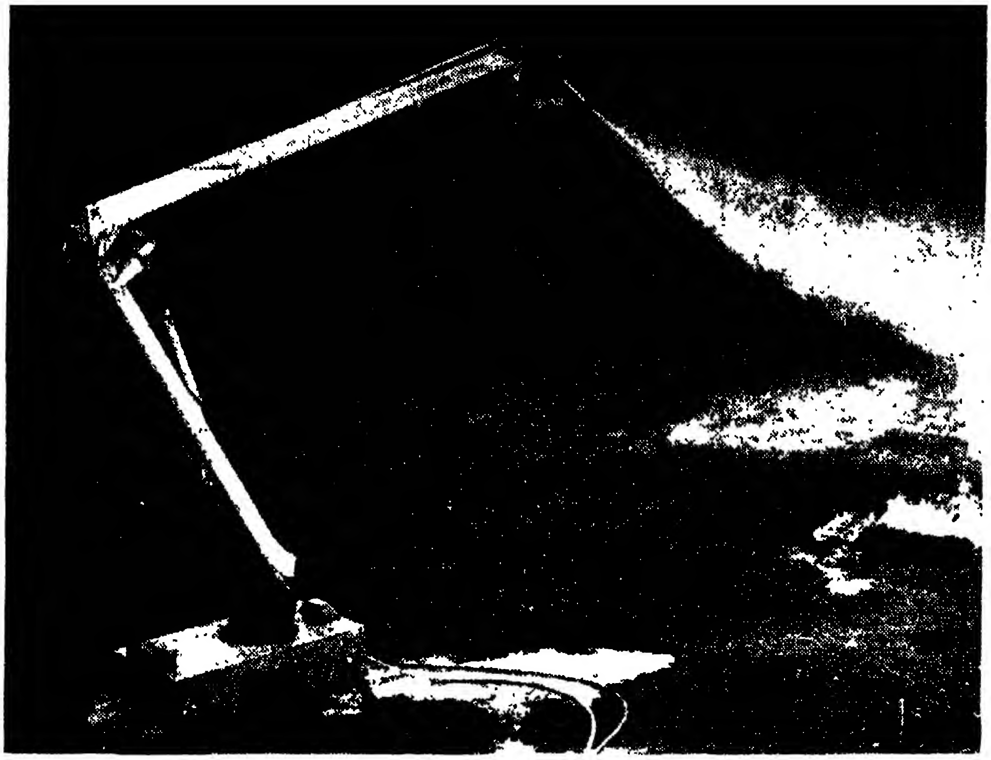
Then there are the twin theatres, with a wall dividing the two auditoriums. That means that exits are only on one side; the balconies, particularly, have one or two exits. Can the over one thousand people in the hall evacuate within 2-1/2 minutes in case of a fire? There is likely to be a stampede, and firemen think they will have a tough time in such an event. Generally, all auditoriums and halls are required to keep wide gangways and aisles to make evacuation easy and to use fire-resistant structural materials under the Cinema and Theatre Rules. While some do so, some do not.

and a British firm have now developed a potassium bicarbonate-based dry chemical. Called "Purple K Powder" and "Monnex" respectively, the powder expands six to ten times on entering the fire and, it is claimed, is twice as efficient as the conventional powder in controlling petrol fires. Dry chemicals and carbon dioxide (it controls fire by reducing oxygen supply) smother liquefied petroleum gas (cooking gas) fires (Class C). Being inert, dry chemical (special varieties) is particularly useful when reactive metals like sodium, magnesium, zinc, etc catch fire (Class D) and also on electrical fires (Class E) in transformers and in power stations where the use of carbon tetrachloride is being stopped as it has been found to be toxic. Water and foam will react with the metal and the hydrogen released will actually feed the fire. And so does carbon dioxide, which contains oxygen.

Meanwhile, fire brigades in many countries are today extensively using light water, foam with a fluorine compound (a surfactant) added to it. Being lighter than water, it floats on oil surfaces, depriving it of oxygen. And unlike a foam surface which can split and let the flame flash back, light water forms an elastic surface which remains intact. Why not make the foam expand 1,000 to 10,000 times so that it knocks out the fire instantly and also settles into a protective blanket? Called high expansion foam, such foam is produced by passing air bubbles through water. It is particularly effective against aircraft fires, spill fires from oil tankers and basement fires where it creates more room for the firemen. The New York Fire Brigade now uses a slippery water to control fires and even riots. With polyethylene oxide in it, slippery water flows smoothly, reducing friction and turbulence inside the hose. It increases water flow by 50 to 70 per cent and squirts the jet a longer distance, thus reducing the quantity of water used.

Cities like Bombay face a perpetual water shortage which often hampers the firemen's work, or strains the water supply system. When two serious fires broke out in one day a few years ago, the city suffered for two days — the Fire Brigade had drawn a heavy supply. Besides, fires in RCC structures, which occur frequently in cities, build up an intense heat which doesn't let the firemen reach near to the fire. The heat should be absorbed by using a fine atomised (tiny droplets) spray of water from a distance. Because of the high temperature, the spray turns into steam which not only absorbs the heat but forms a protective shield. With a water pressure of only 100 psi (pounds per square inch), the present water pumps do not meet these needs; they give only a small

High pressure water pumps. The water leaves the pump as a fine atomised and forceful spray



The snorkel ladder has great manoeuvrability and facility for evacuation. Working on hydraulic jacks and with two separate limbs, it can extend vertically or horizontally, over walls and around obstructions. It can reach a height of about 25 metres in about a minute. The cage-like structure at the end can carry up to six persons in some models. Besides, the fireman himself can manoeuvre the cage easily to train the hose accurately at the fire. The conventional turn-table ladder lacks this manoeuvrability, though it can reach higher (40 to 60 metres). A 40-metre TT ladder takes about 5 minutes to reach its full height. No snorkel ladder is now used in India, but the Bombay Fire Brigade will soon acquire one

spray — three to four metres at the end of a 25-metre jet. A long (about 30 metres) and forceful spray can be obtained by raising the water pressure to around 600 psi. Such a system is being used by Fire Brigades in the US, Australia and New Zealand.

These are some of the developments in fire-fighting methods. While more and more countries are using the modern devices and tools such as plasma jets and dynamite-charged axes to cut metals, aluminised asbestos clothing, etc, our fire services have strangely remained far behind, in the water-foam period. And firemen admit that some major fires and serious losses could have been prevented if they had used these or at least the snorkel ladder which has great manoeuvrability and facilities for evacuation (see picture above). The Bombay Fire Brigade will soon acquire such a ladder, it is said. Usually it takes a big fire, like the recent one in the State Bank in Bombay, to make the authorities (State Governments and Municipalities) think about fire safety. Then some recommendations are made — and kept in the cold store till another fire occurs. The argument seems to be: Aren't the fire services unproductive? And while men from every other developing field are trained and kept informed of the latest techniques, the fire services can hardly boast of such things. Nor is there any research being done.

Meanwhile, some of the big industries and private organisations are becoming safety conscious. Some of the petrochemical industries and fertiliser factories in India have recently installed automatic fire detection and alarm systems, based either on smoke detection or heat sensing, or both. The alarm systems can be made to set off an automatic fire sprinkler placed in the fire-risk area or simply connected to the fire services. Though some of the parts have to be imported, both smoke detectors and heat sensors are now made in India. Working on photoelectric cells or ionisation currents, smoke detectors can give an early warning of a developing fire, but one problem here is that dust can interfere with their working. Yet in areas with a high life risk like hospitals (where strangely there is no alarm system at present) and in places fairly free from dust such as centrally airconditioned buildings, smoke detectors could still be a valuable life-saver. Heat sensors are based on bimetal strips and the difference in their thermal coefficients, or on thermistors which lose electrical resistance with rising temperature. Such heat sensors can be preset to any required temperature at which the alarm goes off. Fire alarm systems are being installed in big hotels and are also planned for the Jumbo jet hangars at the Santa Cruz airport. As research is shifting from fire-fighting to fire alarm, future detectors are likely to be based on infra-red or ultra-violet lights or on lasers. Much work is currently going on in perfecting such systems, where the light beams are reflected through a series of mirrors; any smoke in the path will deflect the light beams and the reflections.

...and burns

M. H. KESWANI
NARENDRA J. PANDYA

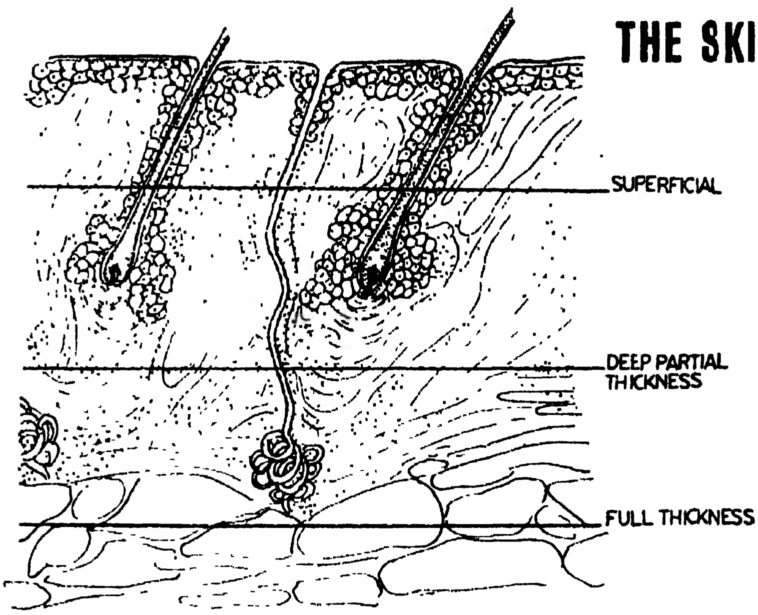
A flame is a beautiful thing. It changes colour and shape. It hypnotises. You like to touch it, feel it, play with it. Sometimes you don't care enough. Then it happens: suddenly the flame is on your skin. It is then you realise there is a deeper truth in the much-maligned cliche "beauty is skin deep"

CIVILISATION, they say, began with fire. And ever since man learnt to tame this god into servility, the human body has also known the most horrid and painful mode of disfigurement and death. Yet, till very recently, burns had remained the most neglected human injury. One reason was ignorance. Not that nobody had tried to look for a remedy, but most were crude, unscientific and at times harmful. The Egyptians doted on a combination of gum, goat's hair and milk from a woman who had given birth to a son. History says, 1500 years before Christ, burns were treated by some kind of linen strips soaked in an oily preparation. Later on, the Chinese and the Japanese used tinctures and extracts made from the leaves — maybe that was how the more recent treatment with tannic acid came into use.

Hippocrates, the Greek father of ancient medicine, suggested melting old swine seams mixed with resin and bitumen, spreading it on a piece of cloth and wrapping in a bandage after warming with fire. In Rome, Galen recommended vinegar or wine. The famous Arab physician, Rhazes (circa 9th century), used ice cold water in the treatment of burns. (This, of course, is a common first-aid practice today in the management of burns.)

The modern methods of burns management came out of western Europe, particularly from France, the United Kingdom and Germany. As understanding of the subject increased, the methods became more scientific. However, it was not until late in the first quarter of this century that the problems of burns were categorised. This led to a definitive treatment and establishment of units with specially trained personnel for the exclusive care of burn victims. Today the discovery of antibiotics and the advances in anaesthesia and skin grafting have not only increased the margin of safety but have also succeeded in bringing hope to the disfigured.

But not to all, unfortunately. The resources available to the medical profession are still limited — far short of helping all those who need help. And the number of those who need help is simply staggering. Though no reliable information is available regarding the total number of deaths and damages caused by burns in India, one can make a guess. For example, in Bombay city alone, approximately 3,000 persons are severely burnt every year and of these approximately 500 die. About 74 per cent of the burn accidents occur at home. Of these, 41 per cent are caused by pressure stoves and 79 per cent of all burn accidents involve women and children. But these are only statistics. If



THE SKIN

STRUCTURE

Epidermis — Consists of a pile-up of epidermal cells. It's the main area of contact with the outside world and is constantly being replaced by new cells produced from its deeper layers

Dermis — Lies below the epidermis in the form of a wavy surface. Is richly supplied with blood vessels and nerve endings. Also has hair follicles and sweat and sebaceous glands

FUNCTIONS

- **Largest sensory organ in the body**
- **Protection of tissue**
- **Lubrication with the help of secretions from sweat and sebaceous glands**
- **Regulation of body temperature**
- **Maintains the shape of the body**

Above: Cross-section of the human skin. A burn reaching down to the level marked superficial would show merely as redness or as blister. If it reaches down to the level of deep partial thickness, it may or may not show blistering. These burns heal without any skin grafting if adequate care is taken. The healing would generally proceed from the undamaged remains of the hair follicles and sweat and sebaceous glands. On the other hand, a burn up to the level of full-thickness is insensitive to touch or pain and looks dark brown or leathery. Since all the epidermal elements are destroyed, this requires skin grafting

you wish to know what burn really means, go and visit any hospital. The screaming agony of the burn victims will tell you what horror the beautiful flame can perpetrate on the human skin. Remember the skin?

Have you ever thought how vital an organ the skin is? When a living thing is born, the skin comes as a tight envelope round his body giving it shape and form. It also acts as an interface between the body tissues and the external environment. A container of shape, a protector of tissues! The skin is also alive; it has many more important functions. It controls body temperature, maintains fluid balance and provides protection against bacteria and harmful agents. Any break or damage in the continuity of the skin results in a wound which opens the door to infection. The wound must heal quickly; sometimes nature does it on her own.

If you take a cross-section, the skin will look like layers one on another — the epidermis and dermis together with their specialised structures like hair and sebaceous and sweat glands. The epidermis consists of a pile-up of epidermal cells. The cells in the lowermost layer are constantly producing new cells which are gradually pushed outwards and shed. The process of shedding generally goes unnoticed unless there is an excess as seen after sunburn.

Deep under the epidermis lies the dermis. This is in the form of a wavy surface and is very richly supplied with blood vessels and nerve endings. The hair follicles and the sweat and sebaceous glands are also located in this layer. The density of the follicles and the glands varies from person to person and also varies from area to area in the same individual. The body hair provides protection and together with the secretion of the sweat glands helps to regulate the body temperature. The sebum, which is an oily secretion of the sebaceous glands, provides natural lubrication for the skin.

Pathology

What happens when the skin is burnt? Minor burns cause redness of the skin. There is intense burning pain but the wound heals easily by shedding the superficial layers of the skin. If the heat is greater, blistering results. (Blisters come out when the epidermis is lifted up due to an accumulation of fluid.) Smaller areas generally heal on their own.

In more extensive burns, the effect is felt by the whole body. The burnt skin shows blisters. The fluid leaves the capillaries and either comes out on the surface or accumulates in the deeper

layers of the skin, due to an increased permeability of the capillaries and the vessels. Only the fluid portion of the blood leaks out leaving behind the red and white blood cells. This reduces the volume of the blood circulating in the body and also creates an increased concentration resulting in thicker blood. Hence less blood reaches all the tissues. The brain and the kidneys are the primary organs affected by this reduced supply of the blood. The blood being thicker, the heart now has to use more force to help circulate the blood throughout the body. This increases strain on an already starving heart. If this is allowed to persist, then the kidneys, the brain and finally the heart give way resulting in death.

This means, in the management of burns replacing the fluid is of greater urgency. The victims complain of thirst and they should be given fluids freely. Over and above, large quantities of fluids must also be supplied intravenously. If this is done in time, the volume of the blood can be restored and the consistency of the blood made normal. That relieves the strain on the heart and helps to meet the necessary blood requirement of all the vital tissues.

First aid

Taking care of the fluid loss is a professional's job — the doctor's. What can you do for first aid? Well to start with you have to do something about the intense burning sensation. You can apply cold tap water, or better still try ice. Ointments should not be applied to the burnt skin. Some of the popular ointments are coloured and mask the appearance of the damaged skin and make it difficult for the doctors to make a proper assessment of the damage. The ointments are also sticky and a lot of time is wasted in removing them before starting the desired treatment. Also remember, burns always create shock. Reassure the victim, stay close by. Burnt clothes need not be removed. It is best to wrap the burnt part with a clean " dhobi-washed " sheet.

Soon after a major burn, the victim feels very thirsty. Water, or a sweetened drink can be given in small amounts (2 oz) frequently. But no milk or food. Drugs should not be given without the advice of a doctor. In the early stages, all drugs are given intravenously, to be effective. It is necessary to reach the patient to a proper burns treatment centre as soon as

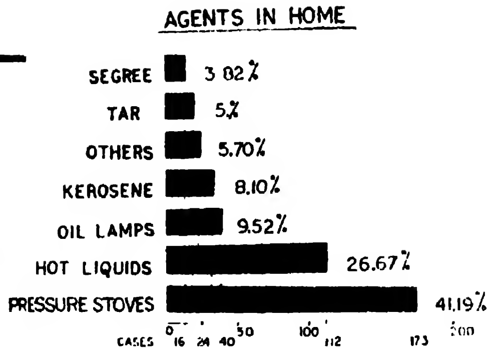
Classification of Burns

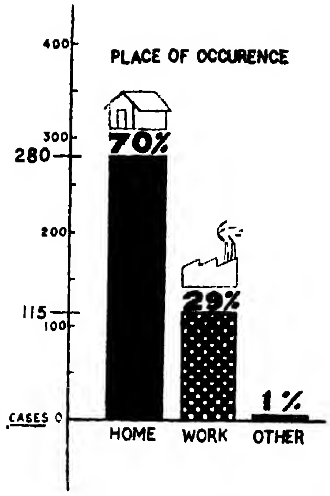
Erythema — **Redness. Burning pain. Increased sensitivity. (More like sun-burn)**

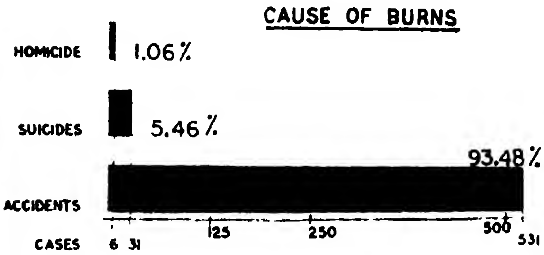
Partial — **Blister. Pink or red or brownish colour. Burning pain. Sensitive to pin-prick**

Full-thickness — **Leathery feel. Dark brown or greyish colour. No blisters. No burning pain. Insensitive to pin-pricks**

Some useful hints & statistics

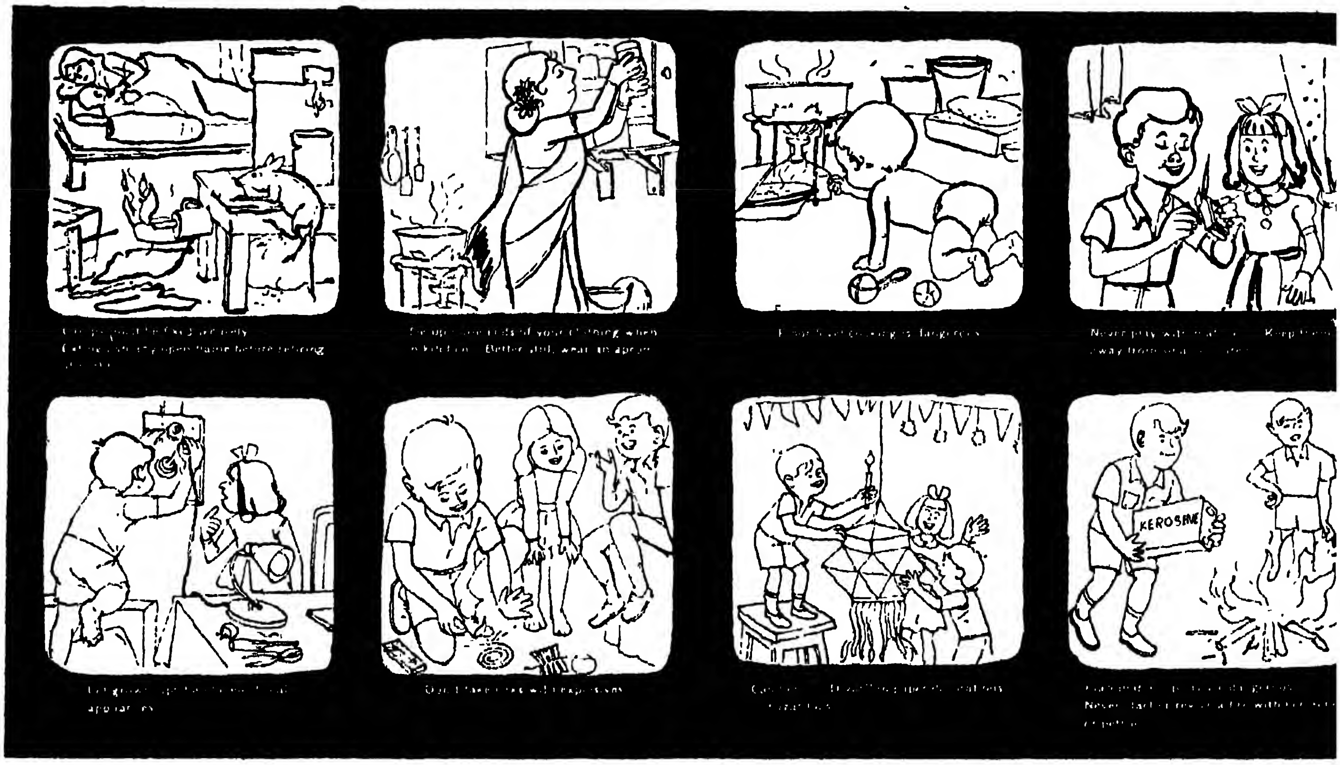






These figures are based on a survey of burn accidents in the city of Bombay by Prafulla M. Somaya published by the Tata Department of Plastic Surgery, J. J. Group of Hospitals, Bombay. Below: A poster campaign launched by the Department

Do not tempt fire



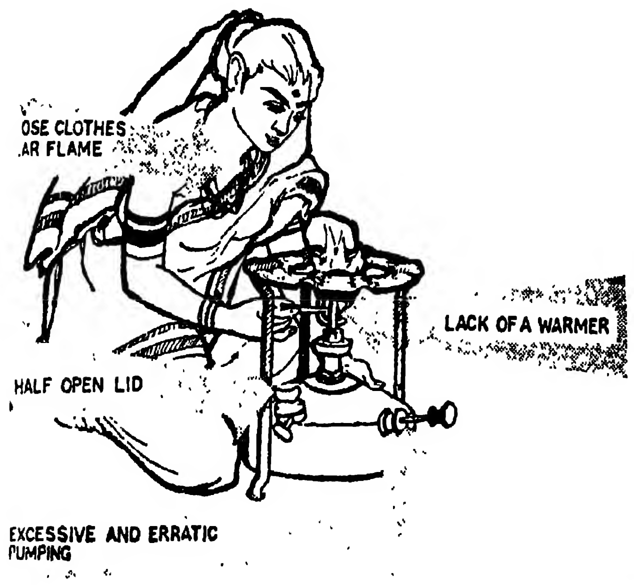
possible in order to commence the treatment of shock and the prevention and care of infection.

Treatment

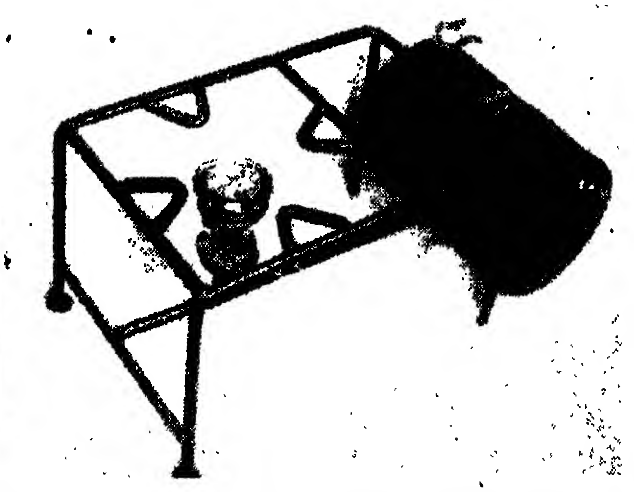
While it will be out of place to enumerate the details of how to treat burns, it will be relevant to describe the guidelines on which treatment is based.

It is useful to know the actual cause of burns, the details of how the accident occurred, how the fire was extinguished and the first aid given. For example, nylon burns rapidly, completely and sticks to the skin till it finishes

THE PRESSURE STOVE



Above : Commonly-used pressure stoves are responsible for a large number of domestic burn injuries. Below is an improved design of a stove. It's four legs give it better balance. The tank is farther away from the flame and the flamehead gives more uniform burn



burning; the damage is more severe. Acids burn deeply. Electricity burns deepest of all, depending on how long the current was passing through the tissues. Electrical burns have hence to be deep-explored to determine the extent of the damage and dead tissues have to be excised to promote early healing.

However, the major determinant of the final outcome is the general condition of the victim at the time of the accident. For instance, burns are more hazardous at the extremes of age. Again malnutrition and anaemia retard healing, because the patient's general resistance is low. Cardiac, respiratory and kidney diseases are handicaps too. So is diabetes. Pre-existing skin diseases predispose to burn-wound infections. Also pregnancy would be a terrible load on a burnt woman.

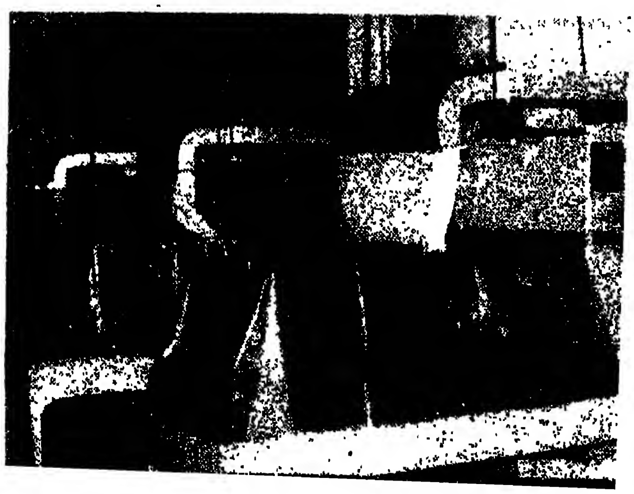
The severity of the burn injury is judged by estimating the surface area of skin that is burnt and the depth to which it is burnt. Of the two, the area of skin burnt is considered to be more significant.

A simple guide to estimating the area of burns in any individual is the "Rule of nines". The head and each upper extremity is 9 per cent of the total body surface; the lower extremities, the front of the trunk and the back of the trunk are each 2 × 9 per cent, i e 18 per cent of the body surface. The genital area amounts to 1 per cent. (It is useful to know that one surface of the hand is approximately 1 per cent of the body surface.)

In terms of severity, burns of less than 10 per cent in children and less than 15 per cent in adults are considered to be minor, except when they involve the face, the hands, the feet or the genital area, or when they are electrical or chemical burns.

Hot-air beds: Experience in Scandinavian countries has shown that control of the immediate environment of a burn victim helps to improve his general condition, prevents infection and heals wounds. This concept of control of micro-climate has resulted in the hot-air bed shown below.

The bed consists of a polythene tent in which the patient is 'housed'. Regulated flow of air is maintained throughout at a constant temperature with the help of heaters. This helps prevent draught and assists wound-healing by early formation of protective scabs



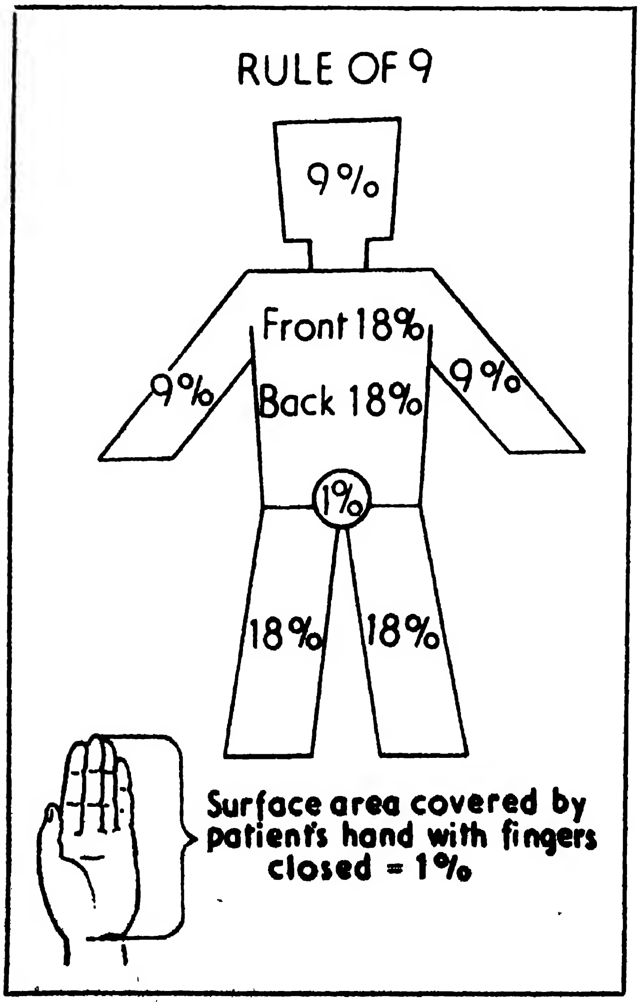
A burn would be considered major if it involved over 15 per cent area in adults or over 10 per cent area in children. The victims are liable to undergo circulatory shock during the first few days after the accident. Burns upto 30 per cent area are serious, while those beyond 60 per cent are invariably fatal. Within this range, all burns can be called serious.

When it comes to the depth, partially burnt skin has the ability to heal spontaneously, but skin which is burnt to its deepest layer can never regenerate on its own. It leaves hideous deformities and must be replaced through corrective surgery.

The shock phase

Soon after a burn injury, the fluid in the blood tends to leak out from under the burnt skin. The leakage is greater initially — during the first eight hours after the accident — and then diminishes gradually over the next two or three days. It is therefore important to replace this loss as early as possible.

We have already said the amount of fluid lost through burn directly affects the blood circulation. Now the urinary output of the burnt person is a reliable index of the efficiency of the circulation. Urine is hence collected and measured every hour. Restlessness also indicates poor circulatory efficiency.



During the shock phase which lasts approximately 48–72 hours in well-treated patients, the digestive system functions sluggishly. There is not much toleration for food. Liquids are much safer; they can be given in small or moderate amounts, and also orally under supervision.

Infection

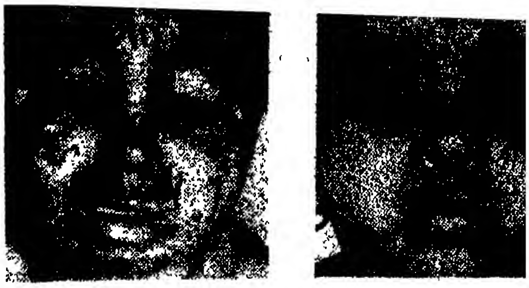
The main problem confronting the burns surgeon today is the prevention and control of infection. The skin is the major barrier between the cells which comprise the body system and the surrounding world. Skin that is damaged opens the portals of the body to invading infection. The germs not only destroy the remnants of the skin cells in and around the damaged area, but also penetrate deeper and finally enter the blood stream and circulate freely. They overrun the body's defences producing a condition called septicaemia. Usually one type of germ predominates, but the ultimate outcome is uniformly grim and often fatal.

Infection can be prevented by protecting the burnt surface from germs. It is controlled by the use of antibiotics and other drugs introduced into the body or by enhancing the body's own defence mechanisms. The burn wound may be protected most simply by permitting the burnt skin to dry up by exposure, forming a protective crust or eschar. If the burn is of partial thickness, the living layers of skin proliferate naturally and in a couple of weeks restore the skin to normal. If the burn has damaged the full thickness of the skin, the dry eschar separates in three to four weeks leaving a large wound which always requires a skin graft for its cover.

The burn wound may also be protected with various solutions or ointments. The most efficacious preparations available are a half per cent solution of silver nitrate or a ten per cent solution of sulphamylon diacetate or ten per cent ointment of silver sulphadiazine. The ointment or solution is wrapped around the burnt surface which is thus " closed " (as opposed to the " exposure " technique described in the preceding paragraph).

Though the exposure technique appears to be very simple, it has, in fact, several practical difficulties. A uniformly thick pellicle must

Wound Care in Burns



Exposure : In this method, the burnt skin is permitted to dry forming a protective crust or eschar. This is washed frequently to prevent infections. The wounds usually heal in 2-3 weeks time if they are of partial thickness. At left is the burnt face of a child ; at right after healing

Dressing : This technique is more suitable for circumferential burn, burn of hands, feet and joints and for burns in children. Either silver nitrate or furacin can be used. This method conserves energy and prevents fluid loss through evaporation

Ointment : This uses typical antibacterial agents. Recent advances have resulted in the use of sulphamylon and silver-sulphadiazine, applied liberally on the burnt surface and left exposed, or maybe covered with a dressing. Mainly used in deep burns

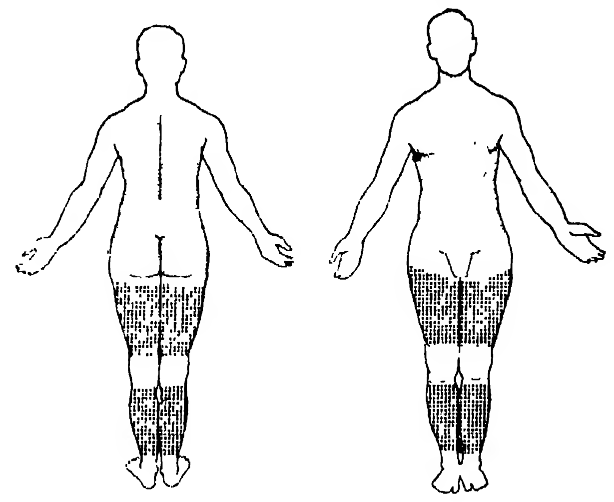
form and it must be prevented from cracking up and getting infected. Often, in this country, what passes for the exposure method is, in fact, nothing but neglect.

The closed technique is more suitable for circumferential burns, for burns of the hands, feet and joints, and for burns in children. Initially, the dressing takes more time and is more expensive — on an average, a dressing costs Rs. 50 per day. However, both the "exposure" and "closed" methods have their absolute indications and cannot be interchanged.

Every effort is made to see that the patient does not come into contact with anything unsterile. All burns ward personnel have to wear masks. The patient is handled after wearing plastic or rubber gloves. Flies are kept out. Visitors are not allowed, except with adequate safeguards.

Where infection supervenes, the appropriate antibiotic is used to control it. Unfortunately, germs have the ability to develop resistance to antibiotics rather rapidly. Moreover, some antibiotics have their own drawbacks. Hence, current research is directed towards developing and potentiating the body's own defence mechanisms. This is done by the repeated administration of small doses of a vaccine produced from the common and lethal varieties of germs. This process is known as "active" immunisation and takes approximately two to three weeks to develop. Where the situation demands a more urgent response, "passive" immunisation is resorted to. In this process, immune bodies produced in some other in-

dividual by previous vaccination are collected and administered till such time as the person's own defence mechanism has been activated by vaccination. The extra immune bodies are present in the donor's serum — known as hyperimmune serum. A vaccine against the common burn wound organism (Pseudomonas pyocyanea) has been prepared successfully at the Tata Department of Plastic Surgery. The preparation of hyperimmune serum is under way.



The drawing shows areas on the body from which skin is obtained to cover burn wounds. The thighs and legs are the most commonly selected sites. The back as well as the front of the torso may be used as donor sites if the other areas are not readily available. It must, however, be emphasised that in intensive burns, very little healthy skin may be available and a surgeon is left with no choice but to utilise the only available skin. But skin from the face and hands is always spared unless for final reconstructive procedures

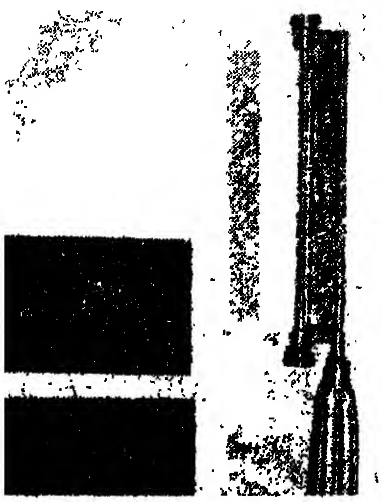
Skin Graft & Skin Banks

SEVERAL recent advances in medical treatment have helped to reduce the mortality following burns. Yet a large-size burn remains one of the most severe injuries any human being can suffer from. The burn destroys the skin which separates during the next few weeks leaving raw open wounds. These wounds must be covered quickly, otherwise infections would set in endangering the life of the individual.

The covering must be done with skin; in scientific terms, this is known as " skin grafting ". And the skin that is most suited for this purpose is one that comes from the victim's own body. But there are only limited areas in the body from where skin can be taken to cover the open wounds. In case the person's own skin is not available, then skin either from another individual or from another species must be used as a temporary cover.

The first, i e when skin is taken from the same body, is known as autografting. The thickness of the skin obtained is such that the " donor " areas would heal in three week's time and can be used separately at every 3 to 4 weeks interval. This skin is

Below, left: Skin graft knife, blade and two wooden boards. Below, centre: Skin is being taken out of the thigh. An assistant holds the thigh from below and pulls the skin taut while another uses a board covered with gauge to pull the skin laterally. In the next photo, the surgeon is using the blade and knife to take skin out by short, swift and uniform wrist motions maintaining counter-action with the other hand with the help of a board



"accepted" by the individual and gets incorporated in the new site within a few days.

If the skin is taken from another individual, this is known as allo-or homograft. In extreme burns, adequate unhurt skin may not be available to cover all the open wounds. This is a dangerous phase. During this period, in order to reduce pain and loss of nutritive blood ingredients and improve the quality of the wounds, they are usually covered by homografts. These can be replaced every three to five days with fresh homografts.

Homograft skin can be obtained from living donors or deceased individuals. Skin from the thighs, back and buttocks are used for this purpose.

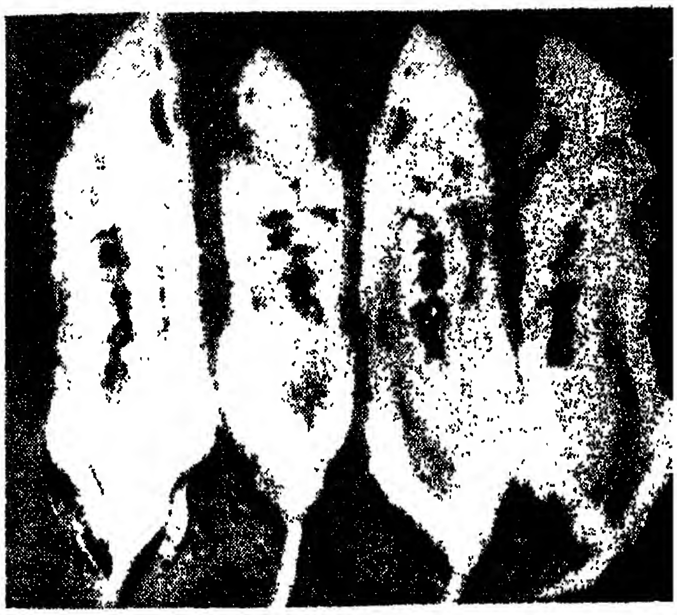
However, the difficulty in obtaining sufficient quantities of homografts has led physicians to look for skin from other species. This kind of grafting is known as hetero or xenograft. Pig or bovine skin usually does well. The use of xenografts is identical to homografts and is also used temporarily.

It must be emphasised that homografts and xenografts are used only for short periods till autograft is available. If used for a prolonged period, they would be "rejected" by the body as foreign tissue.

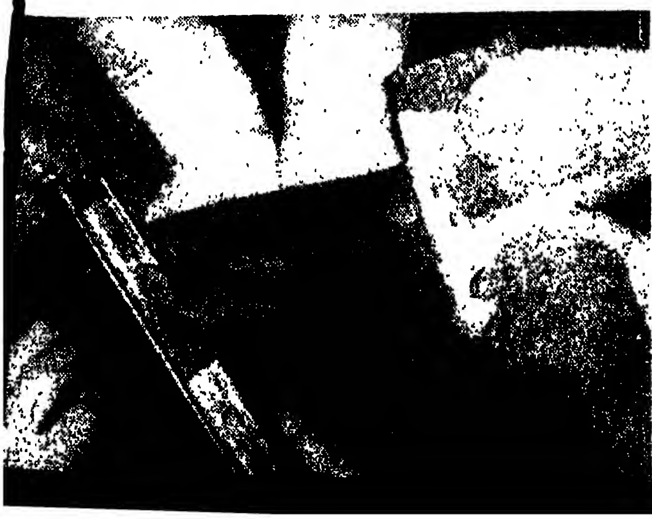
The high incidence of burn injuries and the need for ready availability and uninterrupted supply has given birth to the idea of skin banks where skin could be stored in a variety of ways. Skin may be wrapped up, bottled and kept in the chiller compartment of an ordinary refrigerator and can be used up to 2 to 3 weeks. Or, it can be stored in separate containers of liquid nitrogen vapour where it can be used up to 4 to 8 months. Again, it may be stored after being frozen and dried. In this case, the skin can be used up to 10 years. In the last method, the skin becomes dried like paper and can

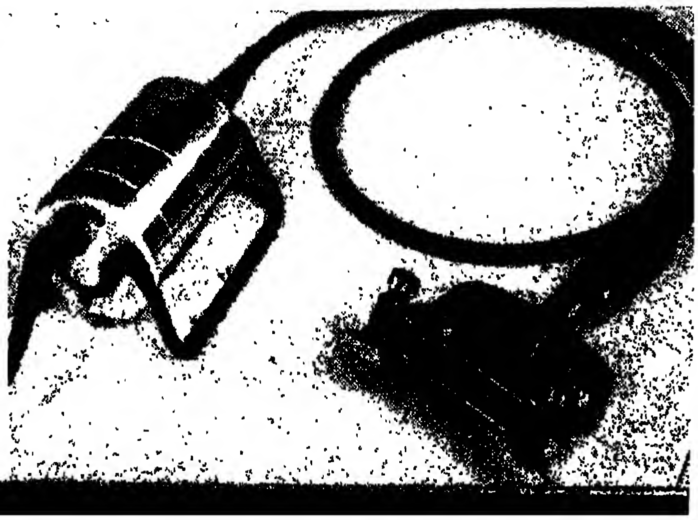
In the West, the search for a suitable xenograft has been going on for the last 50 years or more. Pig skin has been found to be very close to human skin structurally and being readily available has been regularly used as a temporary dressing till autograft is available.

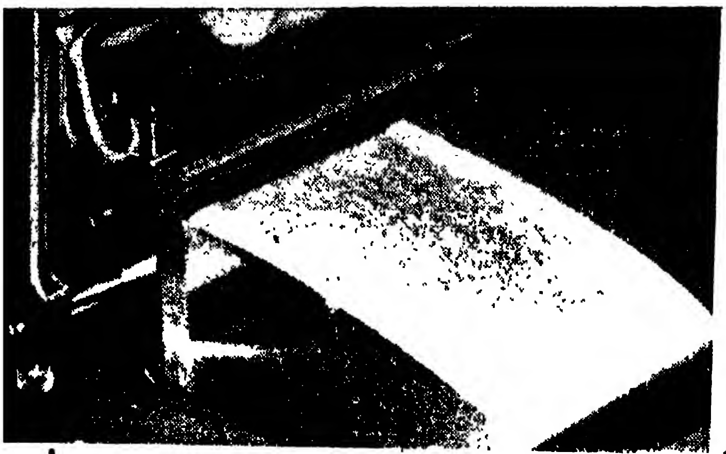
Unfortunately in India, wide use of pig or bovine skin is not possible due to religious sentiments. In order to find a xenograft which is universally acceptable, animal research is going on at the Tata Department of Plastic Surgery with buffalo skin, whose effect on the process of healing in mice is being studied. If it is found to be safe, buffalo skin may be used to treat burn wounds in humans in the near future. Below: Buffalo skin grafted on mice



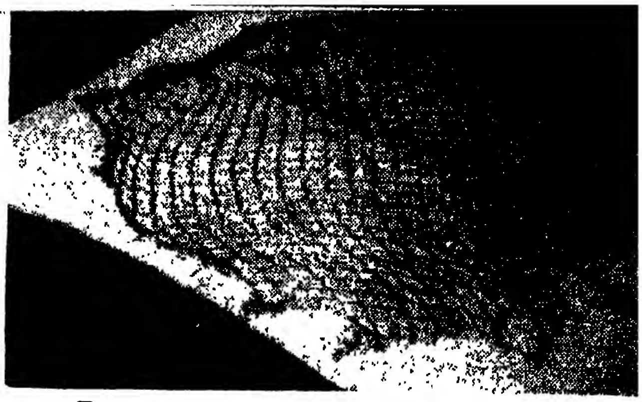
Below : Brown Dermatone, named after its inventor, is available in electric or air-driven models. Cut-skin thickness depends on adjustments of the cutting edge



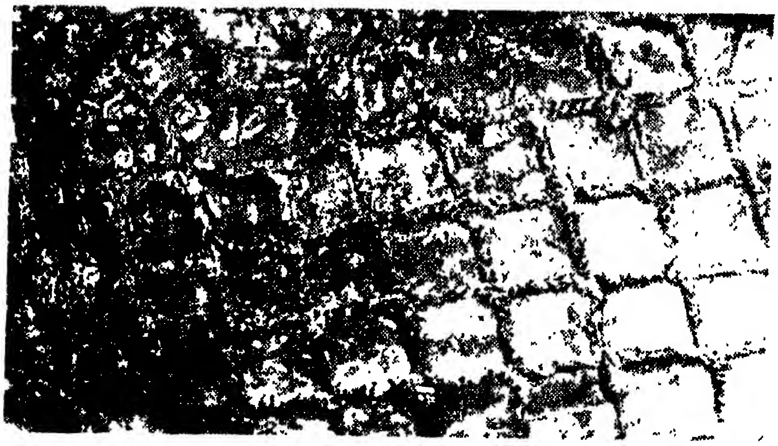




A



B



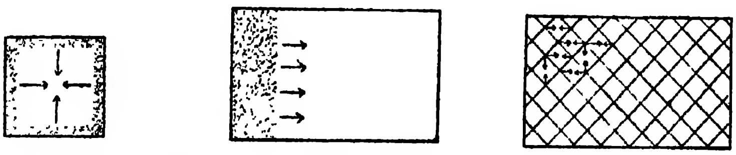
D

C

Mesh-grafting

At times adequate skin is not available from the individual to cover all the raw areas. Various ingenious methods including postage-stamp-grafts, pinch grafts, parallel grafting, etc have been tried in the past. One of the more recent advances is the use of the Tanner-Vandeput mesher. The skin is placed on a special carrier and is introduced at one end and passed between two cutters with the help of a crank. As the carrier advances, the skin is perforated uniformly to the desired gauge and then stretched. A small piece of skin can be stretched up to 9 times its original size

A. Tanner-Vandeput mesher in use. B. The meshed skin before use. C. Seven days after application on the wounds. D. A wound epithelialises (heals) by migration of cells from the surrounding healthy and live skin. If the defect is very large, it may never heal by itself, or else take an enormously long time. Hence skin grafting. By meshing the skin, a larger area of the wound can be covered by converting it into smaller diamonds. Each diamond now does its own covering up by its own cell-migration (see sketches below)



be stored at room temperature and may be transported easily.

Skin banks, however, are yet to come of their own in this country. The reason is the people's attitude towards what they regard as the sanctity of the dead body. When a person dies, the body skin tissues don't die at once. If the skin could be taken out immediately after death, and preserved, we could well be on our way towards a skin bank and saving of several lives. All one has to do is to sign his prior consent, as one does in donating eyes or other limbs. We could maybe take the lead from the Eastern European countries, where the body after death belongs to the state and may be utilised for humanitarian reasons.

(ALL PHOTOGRAPHS AND SKETCHES BY THE TATA DEPT. OF PLASTIC SURGERY)

Reconstructive surgery

Despite the most meticulous treatments, burns often leave deformities, which may either cripple the person or damage him emotionally. He has to be rehabilitated both functionally and psychologically. This is where reconstructive surgery comes in.

Deformities can be of two kinds: cosmetic and functional. The first disfigures the face; the second affects the working of limbs. Here are some common examples where reconstructive surgery has been used to help burn victims :

A. Shows a grossly mismanaged burn of the dorsum of the hand in a child resulting in severe deformity. The wrist was completely stiff and the fingers had very little free movement. All the scar tissue were excised and the wound resurfaced with a skin graft

B. The same hand after reconstructive surgery

C. A 16-year-old boy with a very common form of deformity resulting from a burn involving the neck, the chest, upper and forearms. All the tissues have healed and there is a considerable deficiency of skin. The patient is unable to close his mouth, cannot move his arms away from the body and cannot extend his right elbow

D. After multiple procedure surgery, the patient has regained full movement of his neck, axilla and right elbow

E. A 35-year-old man ten days after being burnt. Destruction of eyelids and part of the nose is evident

F. The same person one year after reconstructive surgery was carried out

Breast-feeding is the best feeding for infants

ALL over the world, infants are spending less and less time at their mothers' breasts. But not, it appears, to their own good. For research is piling up evidence to show that mother's milk is still the best food for infants below six months' age; there is nothing "just as good" -- as yet, according to an article in a recent issue of *WHO Chronicle*. On the other hand, nursing is just as important, psychologically, for the mother.

The reasons for the decline in breast-feeding are varied. Mothers in towns and cities generally have to work away from home, leaving their children with baby-sitters or in crêches, and they have no alternative but to resort to artificial feeding. Advertisements of baby foods also bolster their belief that a shorter period of breast feeding is better. Then there is the tendency to keep up with the Joneses, to imitate the better educated section of the community, where the shorter period of breast-feeding is related to the shape of the breast.

Short spacing of pregnancy is another cause of early weaning. Even where a mother would normally continue breast-feeding for a long time, she may stop as soon as she misses her period; thus, weaning takes place earlier as the intervals between pregnancies become shorter.

In all developed countries, mothers either do not breast-feed or do so only for a month or two. This fashion has spread to the towns and cities of the developing countries, where the period of breast-feeding is becoming shorter and shorter. However in most cases the mothers cannot afford the milk and milk substitutes. The formulation of food may be wrong because of mistaken notions of economy and poor understanding. Those who prepare the feeds often use unhygienic methods, and artificially fed infants are thus more predisposed to gastroenteritis than breast-fed infants, hence early protein calorie malnutrition (PCM). In severe PCM there is markedly reduced resistance to respiratory and other infectious childhood diseases.

Most milk foods are imperfect imitations of human milk. Infants fed on cow's milk or semi-solid proprietary foods may even develop hypocalcaemia (low calcium content in the blood), an excessive renal solute load and an early taste for sugar, with consequent later risk of dental caries. And it has long been known that artificially fed infants are more prone to diarrhoea, both in the West and in the developing countries, than breast-fed infants.

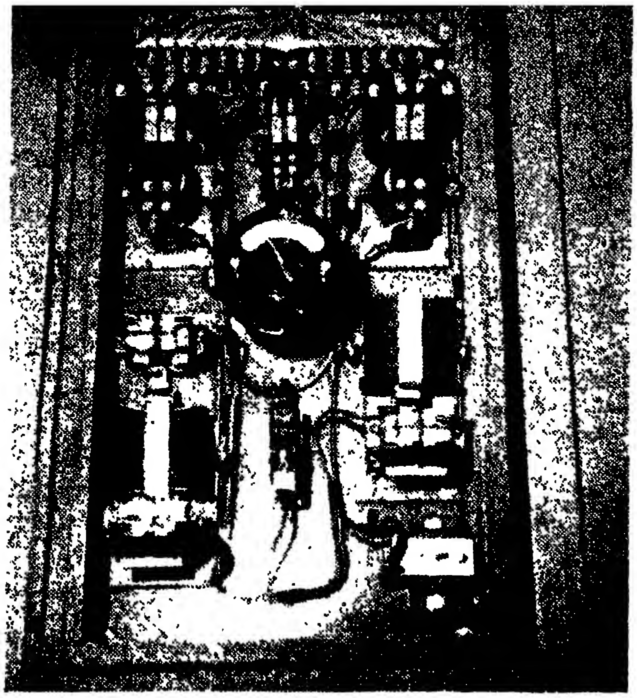
On the other hand, there is growing evidence that human milk is something unique. It has various anti-infective properties and particularly protects against the diarrhoea of new-born babies (caused by *Escherichia coli*) which is common in artificially fed babies but rare in breast-fed ones. Milk is also believed to contain factors which ward off septicaemia of the new-born (caused by *Staphylococcus*). These protective qualities of human milk become important in poor countries where the levels of education and hygiene are low.

Recent studies have also confirmed the popular belief that unimpaired breast-feeding reduces the chances of conception in the early weeks after delivery. Ovulation is postponed until the tenth week after birth.

Breast-feeding is more economical too. It is wrongly believed that a lactating mother needs large amounts of animal protein foods. Her needs can be met equally well by mixtures of

Continued on page 49)

A taste of things to come: a gadget designed not only to relieve the mother of nursing the baby but also of holding the bottle



The device that could help reduce the accident rate on railways

IDEAS & INVENTIONS

It Watches the Engine Driver

"DUE to failure of the human element." How often do we read this phrase in enquiry reports on railway and other accidents ! In the not too distant future, however, most locomotives on Indian Railways should be carrying a device which makes it less easy for the driver to have forty winks, or one for the road, while on duty. The device applies the brakes automatically within seven seconds, when it catches the driver napping.

In the six years from 1957–58 to 1962–63, human lapses were responsible for about 77 per cent of all the collisions on Indian Railways, for 56 per cent of derailments, 85 per cent of averted collisions and block irregularities, and almost 100 per cent of cases of trains passing signals at danger. In spite of numerous technological safeguards, administrative and punitive measures, accidents due to human errors continue to occur. None of the devices earlier developed to keep a constant check on the alertness of drivers have proved foolproof.

The Driver's Safety Control invented by Mr. I. K. Puri of the Indian Railways (now Director, Inventions Promotion Board) is much more effective and foolproof than the existing devices. It checks the alertness of drivers at short intervals and, in case of failure to respond, brakes are applied automatically within 7 seconds. It takes into account all the possible physical and psychological factors that impair the driver's faculties for correct judgement—like reduced physical activity, humming sounds of diesel and electric engines, and the relatively monotonous nature of duties on locomotives or trucks plying on long distance routes.

The system essentially comprises two timers working sequentially. The main timer, which has to be periodically reset by operation of a foot-treadle or any other means that could signify a driver's alertness, controls the vigilance cycle of approximately 45 seconds or 1 km, both adjustable. After completion of such a cycle an audiovisual warning is issued for a duration of 7 seconds by the auxiliary timer. If the driver fails to acknowledge this warning by operating the foot-treadle within the warning cycle, power is cut off and brakes are applied within 7 seconds. If the driver operates the foot-treadle or any other reset switch at any stage within the vigilance cycle to register his alertness, no warning will appear until the expiry of another vigilance cycle. Unlike similar imported devices, Mr. Puri's device is not amenable to tampering.

The twin unit type for twin cab locos

The device is patented in 12 countries, including the USA, the UK, Canada, France, Sweden and Australia, besides India, and comes in three models. In the Electro-pneumatic and Electronic models, the vigilance cycle is of fixed time interval (45–75 seconds); in the Electro-mechanical design, the cycle is controlled by a retractable cam of the main timer that can either be driven from the axle of the

locomotive to issue warnings at constant distance (say, 1 km) or motorised to give warnings at constant time. The electro-mechanical design is ideal for incorporation in the conventional speedometer to obtain the advantages of a compact speedometer-cum-overspeed-cum-vigilance control device.

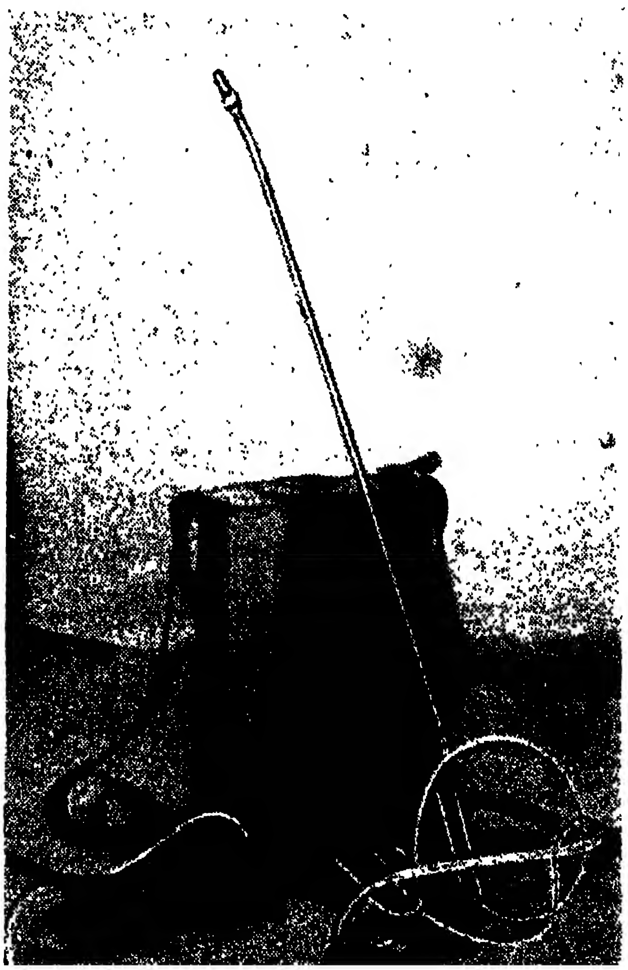
The Indian Railways, it is reported, are going in, in a big way, for installing the new device on all electric and diesel locomotives. The annual requirement of the Indian Railways in the coming years is estimated at 500 units. The device also has considerable export potential.

A Sprayer that Sprays as You Walk

FOR the farmer who can't afford a powered sprayer and who finds the portable, manually-operated sprayer rather tiring to operate, the sprayer invented by Mr. Santokh Singh Khatra is just the thing! It sprays as the operator walks.

Mr. Khatra's patented foot-operated sprayer is unique in that it almost completely eliminates muscle power. Essentially, it comprises a pair of specially designed shoes, adjustable for different foot sizes, with two miniature pumps—each with a piston running in a cylinder—suitably hidden under the heels. As the operator walks, wearing the knapsack-type outfit, the pumps in the shoes operate alternately under pressure caused by his weight. The air pressure so generated forces the insecticide in the container placed on the operator's back out of the spray nozzle.

They look like ordinary shoes, but they contain pumps that pump up the spray fluid as the operator walks



The weight of each shoe is just a little over half a kilogram — which compares favourably with the weight of an ordinary shoe. The container is also very light and easy to carry. The foot-units and the container are connected through polythene tubes. The spray head is sufficiently long to avoid any contact between the operator and the insecticide being sprayed. For spraying on trees and orchards a longer head can be used, as both the hands remain free to hold it.

There are two types of insecticide sprayers in vogue. The powered sprayers are expensive and too involved mechanically to be handled by the average farmer. Of the conventional unpowered sprayers, the stationary ones have obvious limitations. Small farmers prefer the portable unpowered sprayers, as they can be operated by one man and are the least expensive. Still, even these need muscle power and tire the operator quickly—unlike the foot-operated sprayer.

Badiuddin Khan

THE MEDICAL WORLD

(Continued from page 47)

inexpensive plant foods. Recent studies indicate that the expenditure of energy in lactation is about half of what was formerly believed.

Psychologists have also pitched in on the side of breast-feeding. Suckling is an essential part of the sex experience for the female and affects personality and social behaviour. There is a complex psycho-physiological interaction between mother and baby during breast-feeding. But society interposes barriers in the relationship. During their stay in hospital, mother and infant are separated except for brief contacts; both are usually clothed and the mother may even use a "nipple shield" for protection.

However, breast-feeding alone may not be enough for infants aged 4 months or more who are underweight and make poor progress unless the diet is supplemented.

LOOKING BACK...

did the stars foretell?

GABRIEL DANIEL FAHRENHEIT (14 May 1686): How did the temperature of the human body come to be fixed at 98·4°F? The story belongs to Fahrenheit, the first man to devise an accurate thermometer.

Interested in the study of weather and meteorological instruments, this German amateur physicist and instrument-maker felt dissatisfied with the the.mometers devised by Galileo and Sontorio, which, though slightly improved, first by the use of alcohol and then by that of mercury, depended on the expansion of air when warmed. Fahrenheit saw that mercury expanded and contracted more firmly and evenly than air with changes in temperature, and that it could be put in much smaller closed tubes. He therefore substituted mercury for alcohol.

He saw that the freezing point of water and the temperature of the human body could be used as fixed points on his temperature scale. He divided the scale into 12 equal parts (following a suggestion of Newton) and further subdivided each into eight parts. Later he adjusted this to avoid negative readings on really cold days, so that the freezing point of water came out as 32° and the boiling point 180 degrees higher i e, 212°. On this scale, body temperature is 98·4°.

Fahrenheit also found that each liquid had a fixed boiling point, but that this changed with the atmospheric pressure.

The Fahrenheit scale is today used in Britain, the United States, Canada, South Africa, Australia and New Zealand, but the rest of the world has switched over to the Celsius scale. Fahrenheit died on 16 September 1736.

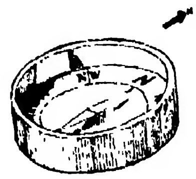
SIGMUND FREUD (6 May 1856): If Copernicus and Darwin revolutionised man's ideas about the physical and animate world, respectively, it was Freud who completed the process by helping man revise his ideas about himself.

Born of Jewish parents, Freud lived in Vienna till Nazi troops occupied Austria in 1938. He began as a doctor of medicine and worked on the nerve tracts and relationships of the nerve cells, but gradually became more interested in psychology. He conceived of mind as having an unconscious and a conscious level and felt that free association — allowing the patient to talk at will — could be employed as a tool for delving into the unconscious. In *The Interpretation of Dreams* (1900) he gave a new meaning to dream interpretation — a highly useful tool in psychoanalysis.

Freud's greatest achievement was to bring sex out into the open and to show how the sexual drive influences a good deal of behaviour that is not overtly sexual. Freud's over-emphasis on sex was disputed by some of his followers, but psychoanalysis for the treatment of mental disorders has come to stay. He died in 1939.

WILLIAM GILBERT (24 May 1544): Originally a physician and a very successful one at that, Gilbert took over and extended the work of Norman and Peregrinus on magnetism. He provided a comprehensive theoretical explanation of the phenomenon in his book *De Magnete* (1600, Concerning Magnets).

Gilbert's contribution to the house of science was to show that the Earth behaves like a huge magnet with its attractive centres near the geographical poles. Experiments with a spherical lodestone had shown him that a compass needle, suspended freely, dips in its vicinity, and at the magnetic poles of the sphere, points vertically. A compass needle behaves similarly with respect to the Earth. Peregrinus believed that the compass needle points to the heavens, but Gilbert showed that it points to the magnetic poles of the planet.



Gilbert also showed that garlic did not destroy magnetism, as was popularly believed; and that the magnetic attraction of spherical lodestones is proportional to their size. But he went astray when he ventured into celestial mechanics. He held that the Earth, the Sun and the planets are giant lodestones acting on objects at a distance and that what keeps them in their courses is a form of magnetism — they move " in the same plane with their axes parallel ", and on account of " the orientating effect of the Earth's magnetism its axis always points to the polar star ".

Much of modern electrical studies began with Gilbert. Questioning centuries-old notions, he showed that electrical properties do not belong exclusively to amber, and that substances like glass, sulphur, precious stones and sealing wax also attract straw and pieces of paper when rubbed. This force however was quite different from magnetism, because while magnets acted only on iron, the amber force acted on a variety of substances.

Gilbert died on 10 December 1603.

EDWARD JENNER (17 May 1749): " I can't catch small pox, because I have had the cow pox." This chance remark of a Gloucestershire milkmaid set a country doctor thinking and led ultimately to the discovery of the modern practice of vaccination as a means of preventing disease.

The doctor, Edward Jenner, had set up practice in the country after having taken his medical degree. He noticed that people who had suffered from cow pox — a disease primarily affecting cows but also humans — did not suffer from small pox.

He collected some small pox fluid and injected it into such persons. They did not get small pox. He repeated this with two boys, one of whom he had previously inoculated with cow pox virus; the inoculated boy did not get small pox, but the other did. Jenner was not able to explain his results, but half a century later Pasteur showed that such diseases are caused by germs. The body reacts to the germs by producing substances called antibodies which put the germs out of action by combining with them. Thus, the antibodies produced as a reaction to the milder disease, cow pox, provide immunity against the more severe version, cow pox.

When Jenner published his findings in 1796, there was a storm, mostly of disapproval. Attempts were also made to steal the credit from him. It is true that early in the 18th century, people in Turkey and China made attempts to catch small pox from mild cases because this would give immunity against severe attacks; but there was no guarantee that the initial attack would be a wild one. The credit for giving a scientific foundation to the idea and for having the courage to experiment with human beings clearly belongs to Jenner.

The word " vaccination " is derived from the Latin *vacca*, meaning cow. Today there are various methods for bringing about immunity against various diseases for which antibodies are used directly instead of through some other disease. Jenner died on 26 January 1823.

JUSTUS VON LIEBIG (12 May 1803): Today it is almost routine for progressive farmers to apply fertiliser to their crops, but it was not so long ago that the German chemist Liebig showed experimentally the need for soil fertilisation. Following up various theoretical studies on the chemistry of plant growth, he thought that plants could not produce mineral salts and that therefore they must get their inorganic constituents from the soil; and in order to maintain soil fertility, these have to be restored to the soil. He chemically analysed the mineral contents of plants and prepared artificial fertilisers containing mainly potassium and phosphate, but not nitrogen. His mistake was to think that nitrogen was not necessary, that all plants got it from the air, as did beans and peas. His own student Joseph Gilbert later established the importance of nitrogen in synthetic fertilisers.

Liebig's great achievement however was a method of quantitative organic analysis, which held the field for the next 75 years. Organic compounds were far more complicated in structure than inorganic ones. By 1831 Liebig developed a technique whereby, from the figures of carbon dioxide and water in an organic compound, accurate measures of the carbon and hydrogen in the original compound could be obtained. Dumas added to this a method for determining nitrogen content.

Liebig believed that organic compounds could be prepared from inorganic compounds, contrary to the established view that the former were produced only by vital forces in living matter — thus tending to bring organic and inorganic chemistry closer together.

In the latter half of his career he became interested in biochemistry. He investigated the constitution of body fluids and showed that the body heat was the result of the combustion of foods in the body. He died on 18 April 1873.

CAROLUS LINNAEUS (23 May 1707): On the face of it, no two creatures can be more different than a whale and a man. They have their similarities, however, similarities which justify their inclusion in the Class Mammalia.

The man who first made a systematic attempt to classify living beings on the basis of their resemblances, and differences, was Linnaeus, the Swedish botanist, whose *Species Plantarum* (1753) and *Systema Naturae* (10th ed; 1758) are recognised as the starting points of botanical and zoological nomenclature.

Linnaeus classified about 18,000 plants known to him. To each he gave a generic name (for the group to which it belongs) and a specific name for itself: this " bionomial system " is followed even today. Higher groupings like " order " were determined by the number of pistils the plant possessed, and the " class " by the number of its stamens. He extended this system of classification to animals, and gave man the name *Homo sapiens*.

Linnaeus' system is artificial and arbitrary because it classifies plants and animals into discontinuous and well-marked hierarchically graded groups by using only a few or even only one characteristic. He ignored relationships, which can be established by studying all known characteristics like stem, leaves, flowers, fruits. But the idea of grouping of living beings into larger and larger categories — the whole resembling the branches of a tree—paved the way for the acceptance of the idea of organic evolution. Linnaeus died on 10 January 1778.

S. N. Munshi

Time is intangible. It requires some repetitive process to mark its passage. Man has used pendulums, electric clocks, electronic clocks, the stars, the Sun, the Earth to measure time. And now he has come up with the most accurate device to date—the atomic clock

THE ATOMIC CLOCK

U. R. ACHARYA

THE function of any clock is to indicate the correct time and its virtue depends on the accuracy with which it can do this. Mechanical clocks can indicate time to an accuracy of about one hundredth of a second per day. That means the clock gains or loses only one second in the course of 100 days. Electronic clocks, based on the oscillation of a quartz crystal, indicate time to an accuracy of 10^{-4} second per day — the clock gains or loses only one second in 30 years. In recent years, an atomic clock based on the oscillations of a caesium atom has been developed and it is claimed that it can keep time to an accuracy of one microsecond or one millionth of a second per day, making the clock gain or lose only one second in 3,000 years. This clock is even more accurate than the astronomical clock and from the first of January 1972, the atomic clock has been adopted as the primary standard for keeping time.

Unit of time

Length, Mass and Time are fundamental physical entities which can be measured. But all measurement is only a comparison against a commonly agreed unit of its own kind. Length and mass have metres and grams as their units and these can be cut and preserved in standards laboratories under stringent physical conditions. But time is intangible. We cannot cut a bit of time and preserve it as our standard unit. We become aware of time by a succession of events — one event following another. Time is thus a flow and can be measured only indirectly by some repetitive process. This process has to be absolutely uniform and unending. The Earth rotates once a day round its axis and it revolves round the Sun once a year. These processes repeat day after day and year after year. The angular velocity of the Earth is, for all practical purposes, constant and, hence, the rotation of the Earth about its axis is used for the measurement of time.

Similarly, the time interval between two consecutive transits of a star across our meridian is called a sidereal day. This is also the time taken by the Earth to complete one rotation about its axis. The sidereal day can be divided into hours, minutes and seconds to get a sidereal clock. But our life is regulated more by the Sun than by a star — by the phenomenon of day and night which is caused by the Sun. Therefore, it is more practical to hitch our clock to the Sun than to a star. The time interval between two consecutive transits of the Sun across our local meridian is called the apparent solar day. This day is longer than the sidereal day by about four minutes because, by the time the Earth completes one rotation, the Earth itself moves some distance in its orbit round the Sun. It then has to turn a little more to face the Sun. If the sidereal clock is set exactly at 12 noon on any day, the next noon will fall at 12·04 hrs. After three months noon will come at 6 p.m. and at 12 midnight after another 3 months. Hence a sidereal clock will be utterly useless for our purpose.

The orbit of the Earth around the Sun is an ellipse with the Sun in one of its foci. According to Kepler's law, the Earth moves a little faster when it is nearer the Sun than when it is farther away. The Sun moves along the ecliptic and the component of its daily motion along the celestial equator (which is inclined at $23\frac{1}{2}$ degrees to the ecliptic) is not uniform. Due to both these reasons, the length of the apparent solar day varies slightly in different parts of the year. Imagine a point which moves round the celestial equator with uniform speed equal to the average speed of the apparent Sun in its yearly motion along the ecliptic. This point is called the mean Sun. The interval between two successive transits of the mean Sun across the local meridian is called a mean solar day and 86,400th part of this mean solar day is defined as a second. This second is the unit of time. Clocks are set according to this mean solar time. As the mean Sun is only an imaginary point it cannot be observed. What is actually observed is the transit of a star across the meridian and from this, the local solar time is calculated by applying proper corrections.

The intersection of the celestial equator and the ecliptic provides a fundamental reference point called the vernal equinox or the first point of Aries. But the first point of Aries is not fixed in space. It moves very slowly in a retrograde direction along the ecliptic. The time taken by the Sun to perform a complete revolution relative to the first point of Aries is called a tropical year. In reality, however, the Sun makes slightly less than one revolution in one tropical year by about 50 seconds of arc.

Astronomical measurements extending over a period of two hundred years have revealed that the speed of rotation of the Earth is not constant when compared with the times of revolution of the Earth round the Sun. From the point of view of constancy, the year seems to be a better constant of time than the day and in 1957 the General Conference of Weights and Measures adopted a new definition of the second as 315,569,25·9747th part of the tropical year for 0 Jan 1900 at 12 hrs ephemerous time. This ephemerous time is the unit of time based on the tropical year. The second of the new ephemerous time differs from the mean solar second by nearly 1 part in 10 million.

The possibility of using the frequency of a spectral line to control a clock, the rate of which would be absolutely constant, was under active consideration for a number of years. It is well-known that the electrons inside an atom move in fixed orbits around the nucleus and the radii of these orbits are determined by quantum considerations. The electron does not lose energy when it revolves in its own orbit but it does so when it jumps from an outer orbit into an inner orbit. If E_2 and E_1 are the energies of the electron in the outer and inner orbits, the difference comes out as a quantum of electromagnetic radiation of frequency 'n' given by the relation $E_2 - E_1 = hn$ where 'h' is Planck's constant. But even in the case of the lightest hydrogen atom, the jump into the innermost orbit produces radiation in the ultraviolet region with a frequency of the order of 10^{15} cycles per second. The jump into the second innermost orbit from any outer orbit produces radiation in the visible portion of the spectrum. But these frequencies are too high to be generated electronically and cannot be used as a standard of time. The highest frequency we can generate electronically is in the microwave region (10^{10} c/s). The lower the frequency, the lower is the energy contained in the quantum of radiation. To produce lesser frequency we should look for transitions inside the atom between energy states involving a much smaller quantum of energy. It is seen that transitions between energy states arising out of the spin of the electron produce radiation in the microwave region. This is about the maximum limit of frequency we can produce electronically.

In a hydrogen atom, one electron goes round one proton in a fixed orbit. Both the proton and electron spin around their respective axes. The direction of the spin of the electron may be parallel or antiparallel to the spin of the proton. Hence there are two different states of the atom with a slight difference of energy between them. When the electron changes the direction of spin from the higher energy to the lower energy state, electromagnetic radiation of about 21 cm wavelength in the microwave region is produced. Such radiations coming from cold hydrogen atoms in interstellar space

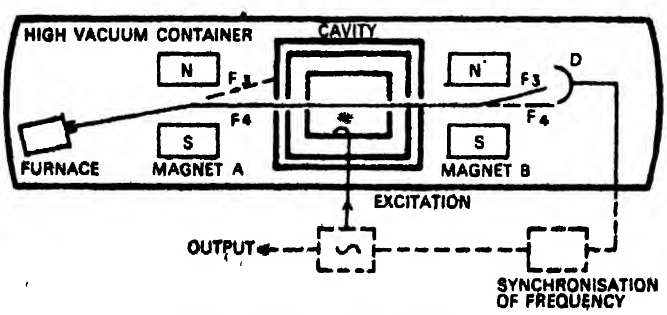


FIG 1—CAESIUM-JET RESONATOR

have actually been observed through radio telescopes all over the world.

Like the hydrogen atom, the caesium atom (At. Weight 133 and At. Number 55) has also a single valence electron with a spin $J = \pm \frac{1}{2}$. The nucleus has a spin (I) equal to $^7/_2$. Since the spin of the electron may be parallel or antiparallel to that of the nucleus, this gives rise to two states of the caesium atom given by the quantum number F where $F = I \pm J$. F in this case can have a value of 3 or 4. This phenomenon is called the hyperfine splitting of the spectral line and is a consequence of the interaction between the spin of the valence electron of the atom and that of the nucleus. The transition of the ground state of the caesium atom from the spin quantum number state 4 to 3 gives rise to a frequency of 9,192,631,770 c/s (nearly 3·3 cm wavelength). This frequency is a fundamental property of the atom and does not depend upon external conditions like temperature and pressure. Also, it has been proved by extensive researches at the National Physical Laboratory, UK, the National Bureau of Standards, USA, and the Swiss Laboratory of Horological Research, Switzerland, that it is possible to reproduce the absolute value of the frequency of caesium atoms with a relative margin of error of $\pm 1 \times 10^{-11}$. In 1967, the thirteenth General Conference of Weights and Measures was therefore convinced that the atomic caesium beam frequency standard had been sufficiently tested to serve as a time base. The following new definition of second was therefore adopted: "The second amounts to 9,192,631,770 cycles of the radiation corresponding to the transition between two hyperfine levels of the fundamental state of the caesium 133 atom". The number has been chosen to ensure compatibility with the old definition of the second based on astronomical observations.

The atomic clock

The heart of an atomic clock is the caesium beam resonator. It consists of a small furnace (Fig. 1) which produces a beam of caesium atoms. Of these caesium atoms, slightly more than half are in the lower energy level F_3 and the rest in the higher energy level F_4. These atoms behave like tiny magnets and the beam is made to pass through a non-homogeneous magnetic field produced by a magnet A. In this magnetic field the atoms undergo deflection depending upon their energy states. Hence the beam is split up into two parts, one containing F_3 atoms and the other F_4 atoms. The beam

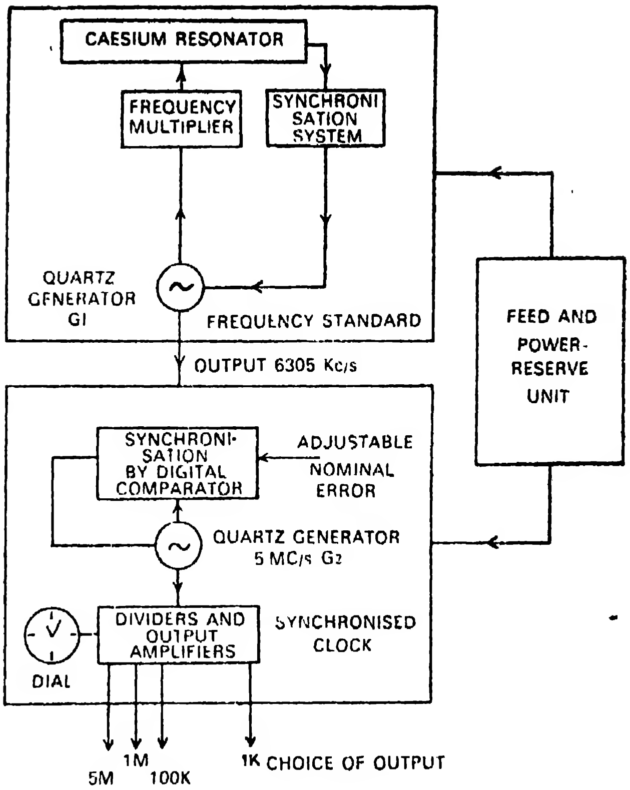


FIG 2 – GENERAL DIAGRAM OF THE OSCILLATOM SYSTEM

of F_4 atoms is passed through a resonator cavity C. The atoms in level F_4 spontaneously jump down to level F_3, emitting the corresponding radiation in the process. But if an external radio frequency generator is connected to this cavity and if its frequency is adjusted so that it is exactly the same as the natural transition frequency of the atom, then, due to the resonance, the largest number of atoms jump simultaneously from level F_4 to F_3 — this is a case of stimulated emission of radiation or maser action. We should have some means of finding out when this resonance occurs.

The beam emerging out of the cavity resonator is again made to pass through another magnet B, producing a non-homogeneous magnetic field, and the beam is again split into two parts F_3 and F_4. This time our attention will be on beam F_3. It is made to impinge on a detector D which is a tungsten plate heated to 1000°C. This ionises the caesium atoms by absorbing their valence electrons. The positively charged caesium ions are passed through a mass spectrograph and caesium 133 atoms are isolated. These ions are, in turn, attracted by a plate with a negative potential and thus a small current is produced. This current is suitably

amplified in stages and the output current is indicated in a milliammeter.

Finding the resonance involves modulating the frequency of the external radio frequency oscillator in a way that the current output from the detector is maximum. This is an indication that the two frequencies are identical and resonance has occurred. Instead of manual operation, the frequency modulation can be done automatically by a servo mechanism based on the error signal obtained at the detector. The complete resonator, consisting of the source, cavity, two magnets and the detector, is kept inside a high vacuum container. The frequency obtained is quite stable. The breadth halfway up the resonance curve is of the order of 90 c/s for the tube manufactured by the Varian Company, USA, and the quality factor (Q) of this resonator is as high as 10^8 — about 100 times higher than the best quartz resonator.

The external radio frequency which is provided by a quartz generator of 6305 Kc/s is suitably stepped up by a series of frequency multipliers. A general diagram of the atomic clock (called oscillatom) is given in Fig. 2. The circuit consists of two control loops. The first synchronisation loop at the top of the figure serves to synchronise the frequency of the excitation quartz generator G_1 to the value corresponding to the maximum resonance. This loop enables the quartz generator to stabilise and supply an extremely stable frequency of 6305 Kc/s. The second loop provides the atomic clock as well as the frequency standards. The output from the first loop is made to stabilise the frequency of another quartz generator G_2 at 5000 Kc/s with a suitable frequency mixing device. The frequency is further divided to 1000 Kc/s and 1 Kc/s by means of the frequency divider circuits. The 1 Kc/s frequency is connected to a synchronous motor and made to run the hands of a clock or a paper tape recorder, making a mark for every second or a fraction of a second. A quartz generator maintains its frequency without any drift for about 10 days at a stretch and, if it is connected to the atomic clock periodically once a week or so, its frequency will remain remarkably steady.

Using the atomic clock

Measurements of time to an accuracy of a microsecond per day has many applications in the fields of science and technology such as space science, radio astronomy, geodesy and aviation. The atomic clock has been used to measure the variation in the Earth's rotation. These variations are of three kinds — secular, seasonal and irregular. A steady slowing down of the Earth's rotation by ·002 second in a century caused by tidal friction in shallow waters has been noticed. The seasonal variation also comes to about ·003 seconds and the exact cause of this variation is not known although many theories have been put forward. But the most dangerous variation for any primary standard clock is the irregular variation which is unpredictable. Between 1963 and 1966 the Earth lost as much as ·06 second in its period of rotation. It is for this reason that the Earth has been given up as the keeper of standard time.

Atomic clocks are also used in guiding missiles and satellites and for effecting mid-trajectory corrections. Four atomic clocks with a stability of 1 microsecond per day are placed, three at predetermined points on the Earth's surface and one on board the missile or satellite. They are all synchronised and each one supplies an exactly determined pulse at the same instant every 1/10 of a second. The pulse produced by the atomic clock on board the missile or satellite is sent by radio to the three land bases and this pulse is received with a slightly different delay in time by each base. The knowledge of the exact difference of each time delay makes it possible to calculate the radial distance from the vehicle to the three land stations and thus fix the position of the missile or satellite in space with an accuracy of a few centimetres.

Atomic clocks have also found applications in air traffic safety, especially around large airports where the growing traffic leads to an increase in the danger of collisions in the air. To prevent these accidents a Collision Avoidance System (CAS) has been developed. It is based on the use of the caesium clock on the ground and in the airplane. Each station taking part in CAS is attributed an interval of 1500 microseconds within a period of 3 seconds. Each station emits, inside this interval, a series of informations permitting other stations to calculate the distance, relative speed and altitude of the emitting station. As the propagation velocity of electromagnetic waves is 3×10^{10} cm/sec, a distance of 3 km is indicated by a variation of 10 microseconds. An electronic device enables the pilot to detect and locate any aircraft flying dangerously close to his own aircraft.

Atomic clocks, with their high precision, can also be used to check the influence of gravity on the clock, proposed by the Theory of Relativity. This is discussed on the following pages.

The clock paradox revisited

ONE of the most hotly debated points stemming from Einstein's Special Theory of Relativity, postulated in 1905, is the clock or twin paradox. The paradox is usually described as a thought experiment involving twins. The twins synchronise their clocks on Earth. One twin then gets into a spaceship and makes a long trip through space. When he returns to Earth the twins compare their clocks again. Einstein himself and many others have argued that according to the Special Theory of Relativity the traveller's clock will show an earlier time than the one on the Earth. In other words, for sufficient speeds in space, the twin may even be able to return to his own great great grand children, who may be older than he is! (see SCIENCE TODAY, p. 58, September 1970).

The paradox of the travelling clocks, or twins, arises from the apparent symmetry of space and time. For an observer on Earth, a clock on board a moving spacecraft will lose time. However, an observer who accompanies the clock on the spacecraft will see the Earth and its clock recede into the distance and then return at a later time. He would think that the clock on Earth is the one that moved and lost time. Clearly both clocks cannot each run slower than the other. This is the heart of the paradox.

Einstein's special relativity is only valid for transformations between what are known as inertial systems. A body in an inertial system remains at rest or moves with constant velocity if no forces are acting on it. If a system is accelerated—that is, if its velocity changes either in magnitude or in direction — the inertial properties are destroyed. Einstein and his supporters tried to get out of the clock paradox by noting that there is no symmetry in the motions of the two twins. One of them, the space traveller, will change the inertial frames three times: while leaving the Earth, while slowing down somewhere in outer space to turn around for the return journey, and then while slowing down to return to Earth. The twin on the spacecraft will age less because of these periods of acceleration and deceleration.

However, this answer did not satisfy the opponents of the ageing effect like Prof. Dingle of England and Prof. Mendel Sachs of the United States, who still argued that not only velocity but also the acceleration is symmetrical with respect to the motions of the two twins. If the space twin is accelerating away from the twin on the Earth, the Earth twin is equally and oppositely accelerating away from the space twin. According to them no explicit refutation of such symmetry between the accelerated motions has been demonstrated by the proponents of the ageing effect.

Einstein and his supporters were least perturbed by this argument. They brought in the principle of equivalence — the equivalence of gravitational forces and inertial forces — of the general relativity theory propounded by Einstein. They attributed the physical effect — that the clocks lost their original synchronisation — to the gravitational action of the rest of the universe on the clock that is accelerated away from the stationary one on the Earth. They thus brought the whole universe in the picture and stated that from the frame of reference of the stationary clock, the second clock moves with respect to it and a stationary universe. On the other hand, from the frame of reference of the moving clock, the stationary clock and the mass distribution of the universe relative to the Earth moves away from it. In the first view then the universe is stationary, whereas in the second it is moving, making the two clocks inequivalent and thereby accounting for the alleged effect.

Many experiments have confirmed that the time measure of a moving clock is different from the corresponding time measure of a fixed clock, from the point of view of the twin on Earth. Recently, the slowing down of a clock due to gravitational forces has also been demonstrated using atomic clocks and the Mossbauer effect. It had been foreseen that probably only an atomic clock taken on a long space voyage and brought back will provide a final answer to the clock paradox. Now two American physicists have done exactly this and given a little veracity to the arguments of Einstein and his supporters.

About two years ago, Prof. Joseph Hafele of Washington University, Saint Louis, Missouri, USA, realised that the speed of commercial jets and the precision of atomic clocks are suitable for an experimental test of the clock paradox. He calculated that if a clock circled the globe on a jet airplane travelling at an altitude of 10 km and with a speed of 300 metres per second, the time change relative to a stationary clock on Earth should be about 100×10^{-9} seconds or 100 nanoseconds(ns). This value is easily within the capabilities of portable atomic clocks.

Prof. Hafele associated himself with Richard Keating, an astronomer at the Naval Observatory, Washington DC, USA. Keating was involved in the business of transporting atomic clocks for calibration with the master clock at Washington DC. With four extremely accurate atomic clocks obtained from the US Naval observatory, Hafele and Keating flew around the globe, in both easterly and westerly directions. The time changes were monitored by an assembly of atomic clocks at the Naval observatory.

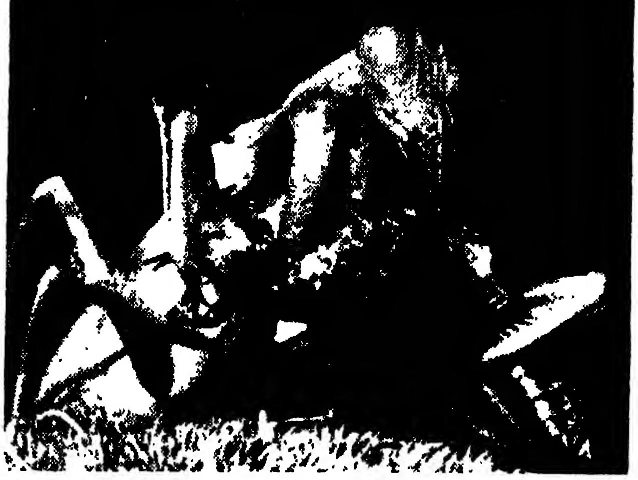
In order to predict the time change between the two clocks, Hafele had to assume that he was an observer in an inertial system outside the Earth. He calculated the time change for both clocks from this new vantage point. Since the Earth rotates from west to east, if all the time changes were due to motion, the jet-bound clock would lose time on the eastward circumnavigation and would gain time in the westward direction. However, things are not this simple. Due to the gravitational effect, the Earth-bound clock will lose time with respect to the airborne clock irrespective of the direction of travel. The effect of the gravitational force is comparable to the shift in time due to the relative motion of the clocks; all of these are about 100 ns. However, in the eastward flight the two contributions to the time difference will cancel, and for the westward flight they will add up. Hafele predicted that the atomic clock on the jet would lose 40 ns on the eastward flight and would gain 275 ns on the westward flight. Preliminary results show that the eastward clock lost 50 ns while the westward one gained 160 ns. Although these figures do not agree exactly with the theoretical predictions, they are definitely on the right track.

K. A. N.

"I think you should read the health warning on the packet."

THE INSECT WORLD

THE PRAYING MANTIS



SUMATI K. SAMPEMANE

IT sits still as death, hands raised to the heavens in an attitude of prayer. It watches silently as a little insect flutters to and fro among the bushes, unaware. And suddenly the praying mantis shoots out a forelimb to catch its prey in a vice-like grip. The speed with which it strikes is incredible; its forelimb moves faster than the naked eye can discern, in about one-twentieth of a second. And once the struggling prey is trapped it proceeds to eat it even before the victim dies. That over, the praying mantis waits again, camouflaged by the background, for the next meal.

Its name comes from the way it sits — in a perpetual attitude of prayer. In fact, the name 'mantis' can be traced back to a Greek word meaning prophet or soothsayer. And it certainly looks like one. It rests on its four hind legs, with forelegs folded upwards. In Islamic countries it was believed that the mantis always prayed with its head turned to Mecca. But it would have been equally appropriate to call the insect a preying mantis as it is one of the most predaceous insects in existence. It is essentially carnivorous, eating only prey food.

Above: The praying mantis gnaws appreciatively at the locust's equivalent of a drumstick. The large part of the locust already eaten, clearly seen here, had disappeared within a minute or two of the start of the meal

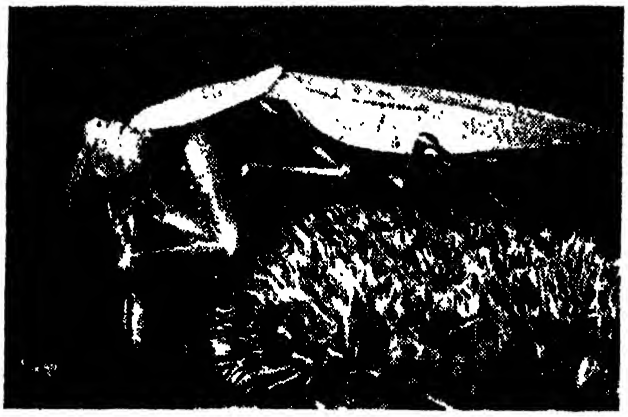
Though the praying mantis has wings and sturdy legs, it prefers to lie in ambush to capture its prey (it can fly when disturbed but only for short distances). Camouflage is its main asset in hunting because it can easily blend with its surroundings. Some have flattened parts, shaped and coloured to resemble fresh green leaves or dry wilted ones or even sticks. Some change colour during the night and day. The orchid praying mantis has flower-like, colourful, flattened hindlegs that attract butterflies and other insects.

Its long forelegs are armed with spines. The joint called the tibia folds over the preceding joint, the femur, like a penknife blade. The spines help to hold the prey more firmly. The insect has an additional asset — very keen eyesight. However, there is one drawback — though it can get a fairly accurate picture of an object directly in front of its eyes, objects to the side appear in bizarre, blown up shapes. Thus it always has to turn its head and look directly at an object to see it well.

Unlike most insects, the praying mantis has a moveable head on an elongated neck and unusually large eyes. It can thus stare steadfastly at its prey without moving and giving away its presence. Once a prey is spotted the mantis never lets it out of sight but moves in slowly till it comes within striking reach. The hairy cushions on its thorax and neck touch the back of its neck. Each hair bends differently thus helping the mantis to calculate the relative position of the insect to the head. A special muscle keeps its head from moving once it is fixed on the position of the prey. This signals the forelimbs to strike. If the sensory hair is removed or if the nerve leading to it is cut, the mantis loses in aiming accuracy.

The slender, more active male seldom arouses any emotions of love or romance in the powerfully built, bulky female. It just whets the female's appetite. The male always approaches its mate with caution, freezing the moment she comes in sight. Then slowly, very slowly, at the rate of a couple of centimetres an hour, the male creeps towards the vigilant female. When sufficiently close it springs on her back, clasps her firmly and strokes her with its feelers. If, however, the unfortunate male is spied before it can make contact, the female kills it.

The female shows no outward response. Turning around coolly, it bites off the male's head and begins eating. The remnant of the male's body meanwhile moves out of reach and continues to mate. Mating in the male is controlled by a nerve centre in the head. This



The last of the locust. The voracious praying mantis comes to the end of a hearty meal

nerve centre inhibits mating till the female is firmly clasped. When the cannibalistic female removes the nerve centre, the male is freed of its inhibitions. This has been proved experimentally also. Beheaded males were shown to readily mate when placed on the back of any female. Headless insects can always right themselves when unbalanced and even walk a few steps when prodded.

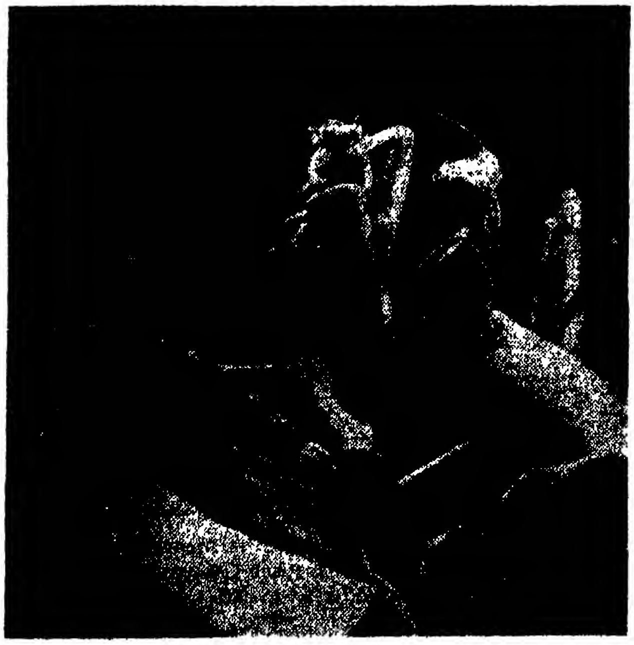
The cannibalistic tendency provides the female and its developing eggs with the necessary nutrition. But males don't die every time. If the female is well-fed, it may not attack its mate. Or if the female is eating during mating, the male gets away unscathed.

The female lays its eggs on a twig or a post in cases called ootheca. These cases have a particular size and shape. As the eggs are laid, the female gives out a gummy liquid and churns it into a frothy mass with the movements of the abdomen. This liquid is made of substances that harden quickly, thus enclosing each egg in a protective capsule. The composition of the capsule is very similar to the ootheca of locusts. Each capsule is provided with a hatch through which the young can escape. Each ootheca may contain as many as 20 to 40 eggs. A female builds about 20 such spongy nurseries in its lifetime.

The young hatch together and hang from the capsule wall by means of silken threads from the hind part of their bodies. After the first moult, the ability to produce silk is lost. The young look like ants and lack wings. As they grow they separate from each other and become solitary, cannibalistic insects. They moult a dozen times before reaching adulthood and in the process they develop fan-shaped wings. Once they become older, they strike at any sizeable moving object. They are as predaceous as the adults though their prey must naturally be smaller.

Except for a type of wasp that captures and kills it, the praying mantis has none to fear in the insect world. This particular wasp confuses the mantis by darting all around it, pouncing on its back unawares and killing it with its

Below, left: A praying mantis stalks its prey — a bee — as a cat does a bird. It is admirably adapted for concealment among the foliage of trees and shrubs in which it lives. Below, right: The forelegs, which are provided with sharp spines, have struck and the bee is held securely, drawn up to the mouth and devoured



sting. Another wasp parasitises on the praying mantis. It lays its eggs in the unhardened mantis optheca. The young then thrive on the host's eggs.

Outside the insect world, birds and lizards are dreaded enemies. Its sole protection against such foes is its camouflage that helps it in its hunting forages. When threatened, the mantis rears up and spreads its forelimbs menacingly. One mantis species has distinct eye-like markings on its wings which are spread out to deter foes.

The praying mantis is classified, along with the docile grasshopper, the voracious locusts, the chirping crickets and the stick insects, in the order orthoptera. The 1800 odd mantis species all belong to the family mantidae. There are five genera on the Indian sub-continent. Some are extremely small and feed solely on insects and caterpillars. Others grow large enough to devour small birds and lizards.

There are mahy odd beliefs centering round this odd insect. For instance, some erroneously feel its dark-coloured saliva causes blindness in men. Others claim that any cattle that swallowed a praying mantis along with hay or grass was sure to die. Praying mantis' do kill a few useful insects, especially bees. But they are not pests. In fact, they help to curb the numbers of fast-multiplying pests. In the US, where the mantis was introduced from China and Europe, they have spread widely and have in the process advertised their useful qualities to all the world.

BRAIN TEASERS

Boys and girls

Ramu is a staunch advocate of the family planning programme. And, of course, he has only two children. One of them is a boy. Now, what is the probability that both his children are boys?

And again, another family planning enthusiast, Shekhar, also has two children. The elder one is a girl. What is the probability that both are girls?

Rupees and paise

Mr. Gupte went to the bank on Friday morning to cash a cheque. All went well but for one thing — the bank clerk absent-mindedly switched the rupees and paise when he paid out the money. Thus Mr. Gupte got rupees instead of paise and paise instead of rupees in the amount cashed. He went out and bought a sweet for five paise for his little son. Counting his money, he found he had exactly twice as much as his original cheque. What was the amount of the cheque?

Eenie meenie mina mo.....

When it comes to dividing a cake in two, there is an easy way out to ensure fairness: Let one person cut and the other choose. But what if there are more than one person? If there were *n* persons who cut a cake into *n* pieces, how could they work out a method whereby each feels he has 1/*n*th of the cake?

(Solutions next month)

Solution to last month's Brain Teasers

Those expensive spoons: 74 paise each.

Paper chase: Nine kilometres per hour. Cycling from half way, going back the full way, Ramu cycled three times as far as he would have walked. So arriving at the same time as if he had walked, he must have cycled three times as fast as his walking speed of three kmph — or nine kmph.

Up the boys: Eleven and seven. If the younger is x years, the older is $x + 4$. The difference between the cubes of their ages is $(x + 4)^3 - x^3 = x^3 + 12x^2 + 48x + 64 - x^3 = 988$ ie, $12x^2 + 48x = 924$ or $x^2 + 4x = 77$ or $x(x + 4) = 7x11$. Therefore $x = 7$, $x + 4 = 11$.

Sharing mangoes: Eight mangoes.

Electronic Engine Overspeed Indicator/Alarm

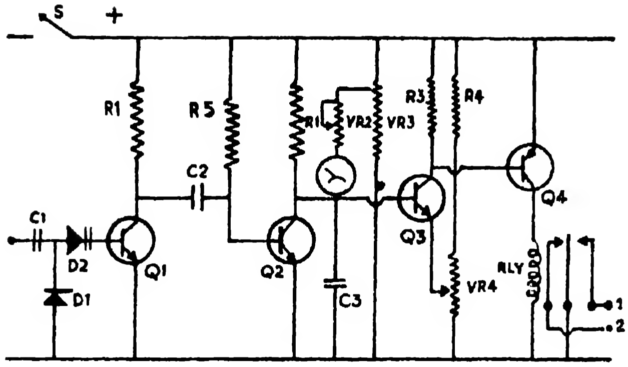
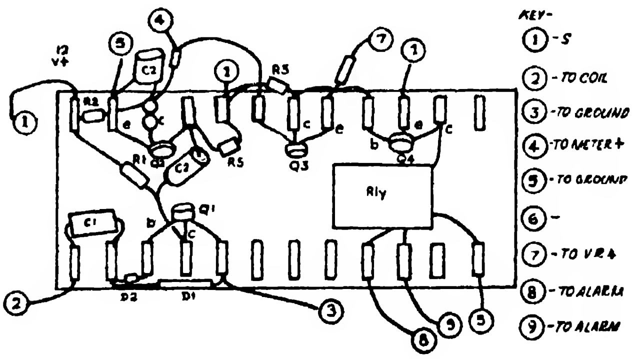


Fig. 1 The circuit diagram of the electronic engine overspeed indicator/alarm

THE siren wails. You look around and you have a traffic police van on your tail. You stop and wait and get a summons for over-speeding. And all the while you've been thinking you were safely under the speed limit. This is not an uncommon happening. Cars tend to creep up over the speed limit without your noticing it. And, of course, there is the problem of concentrating on the road ahead and at the same time glancing repeatedly at the speedometer.

Automobile engines will run at a certain speed for short durations only. If you were to run your car at top speed for a long time the engine will wear out fast and often even break down while running. This makes it essential to know the engine speed of your car and, in this respect, an overspeed alarm would be an attractive proposition. These electronic engine speed meters/alarms can give you an accurate reading of the engine rpm (± 2 per cent accuracy). The reading is very linear as the



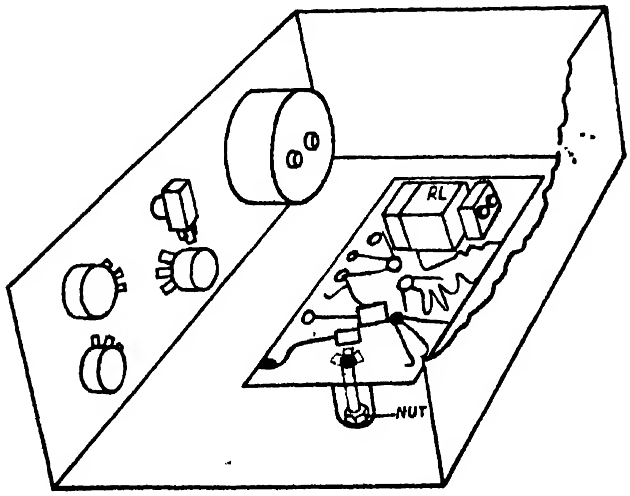
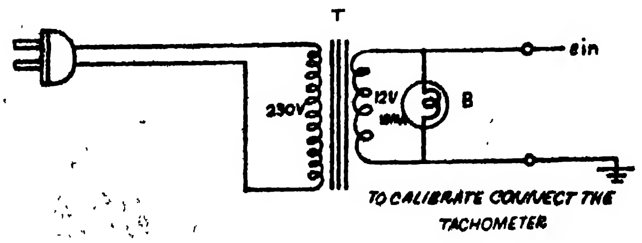
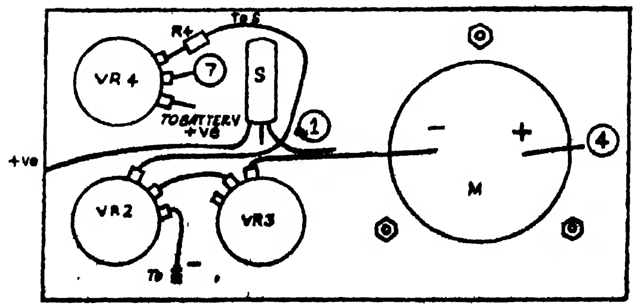
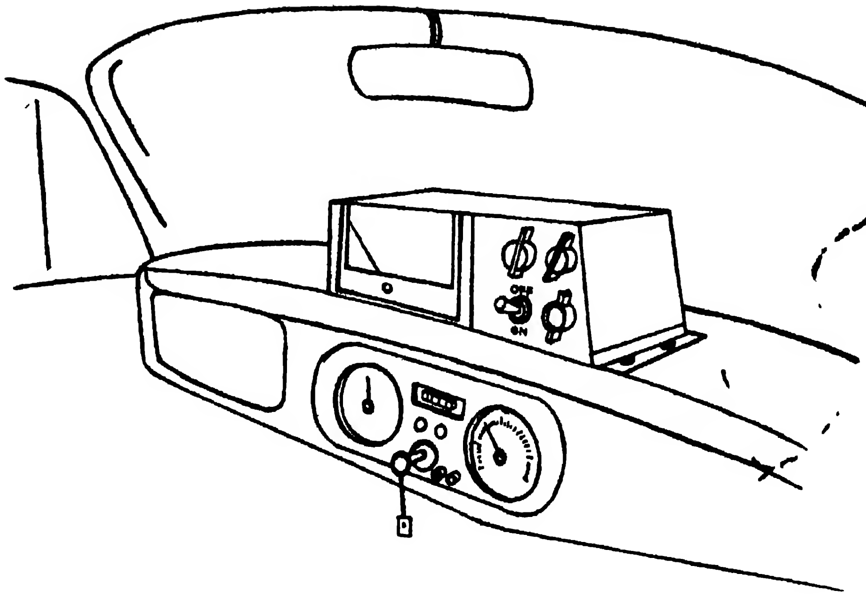


Fig. 2 (above, left) The circuit board connections of the indicator. Fig. 3 (above, right) The components mounted in an aluminium box. Fig. 4 (below, left) The circuit for calibration. Fig. 5 (below, right) The connections of the potentiometers, etc







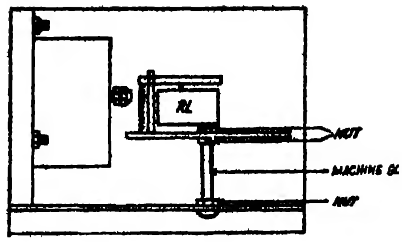


Fig. 6 The indicator mounted in the car

meter is all-electronic and has no moving parts. Therefore, there are also no wear and tear problems.

The meter is actually an electronic tachometer with an additional alarm. The engine speed is displayed on the meter face, the alarm adjustment can adjust the alarm speed. To set the alarm, run your car at the speed limit and then turn the knob VR_4 clockwise till the alarm sounds. Once you slow down again the alarm shuts off.

The meter works with ignition breakers. These breakers act as a switch that turns on twice per engine revolution. This lets the meter know the precise engine rpm. The circuit has a "one-shot" multivibrator which stabilises temperature drift, thus making for a very stable circuit.

When the engine is running, the breaker points send a pulse to C_1 which is transmitted via D_1 and D_2 to Q_1. Thus every time a pulse is sent to C_1, Q_1 conducts for the duration of the pulse. Q_1 and Q_2 form the multivibrator. When there is no pulse Q_1 is off but Q_2 conducts. When a pulse occurs Q_1 conducts while Q_2 stops conduction for a fixed time interval after which the two revert to their normal stage. This principle makes the meter accurate and stable as the amount of power delivered to M_1 at every pulse is fixed ($V \times mA \times T$ where V = volts, mA = current and T = time). The meter thus deflects an appropriate linear amount for each pulse rate. Q_2 charges C_3 to a certain voltage. This voltage is proportional to the engine rpm. The circuit also has Q_3 and Q_4 which monitor the voltage across C_3. If this voltage exceeds that across VR_4, the relay R1 pulls in thus connecting the alarm to the current supply and turning it on.

If you wish to construct the device, use a paxolin board circuit board (Fig. 2). Solder the components to the terminals. Take special care in soldering diodes D_1 and D_2 and the transistors. Double check to see that all the polarities are correct, especially for C_3. Mount VR_2, VR_3, VR_4, S_1 and M in an aluminium box and mount the circuit as in Figure 6.

To calibrate the tachometer, connect a transformer with an output of 12V 50mA/input mains 230V 50 cycles to the mains and connect the 12V side to C_1 and the negative side respectively. Then turn VR_2 till the meter reads 0.3mA or 1500 rpm. Check the accuracy periodically. Adjust VR_3 for zero adjusting the meter M. For adjusting scale length use VR_2.

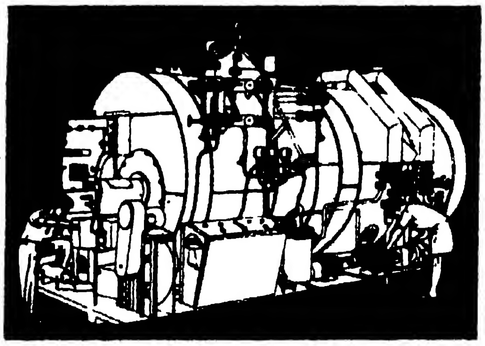
You will need:

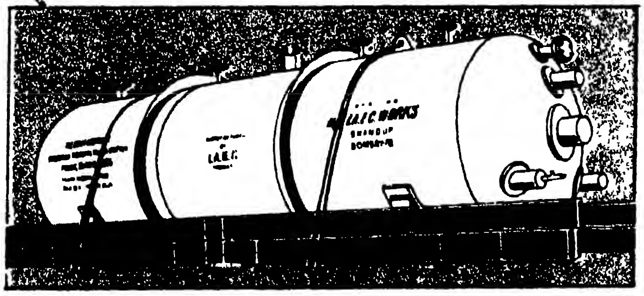
Transistors : Q_1, Q_2, Q_3 — CIL 521 ; Q_4 — CIL 295 ; *Diodes :* D_1, D_2 — 100PN, 50mA, silicon ; *Condensers :* C_1 — 0.1 mfd, electrolytic, 25V ; *Resistors :* (all ½ watt, carbon, 10 per cent) R_1 — 1.8K ; R_2 — 2.2K ; R_3 — 1K ; R_4 — 1K ; R_5 — 15K ; *Potentiometers :* VR_2, VR_3, VR_4 — all 10K, 1 watt, wirewound linear, 10 per cent ; *Relay :* Any 9V at 200 ohm coil resistance (DPDT) ; *Meter :* Any 0-1mA, moving coil milliammeter, 150 mm dial (Simpson or BPL) ; *Miscellaneous :* aluminium box, knobs, hooking wire, circuit board, solder, etc.

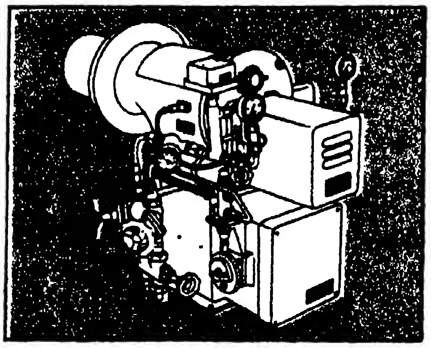
F. Rehman

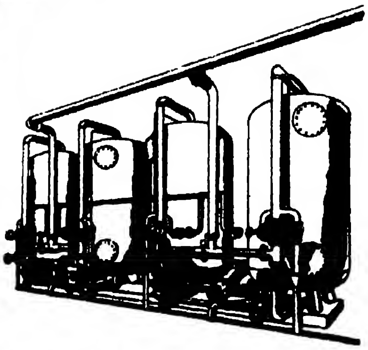
Regd. No. MH 1368

PLANT AND MACHINERY MATCHING THE WORLD'S BEST FROM I.A.E.C.



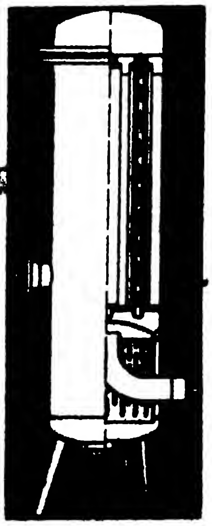


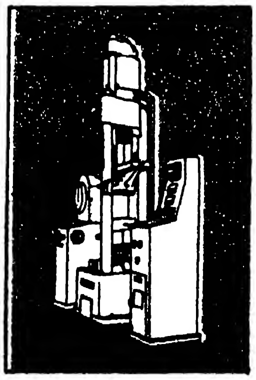




Automatic Package and Non-Package Boilers, Water Treatment Plants, Thermal Power Station Condensers, H.P. & L.P. Feed Heaters, Oil & Gas Automatic Burning Systems, Pressure Vessels, Compressed Air Filters, Material Testing Machines.

I.A.E.C. meets the growing industrial needs of the country with products of technological excellence matching the very best in the world.





Manufactured by:

I.A.E.C. WORKS

Bhandup, Bombay-78.

Manufacturing Division of:

IAEC (BOMBAY) PVT. LTD.

43, Forbes Street, Bombay-1

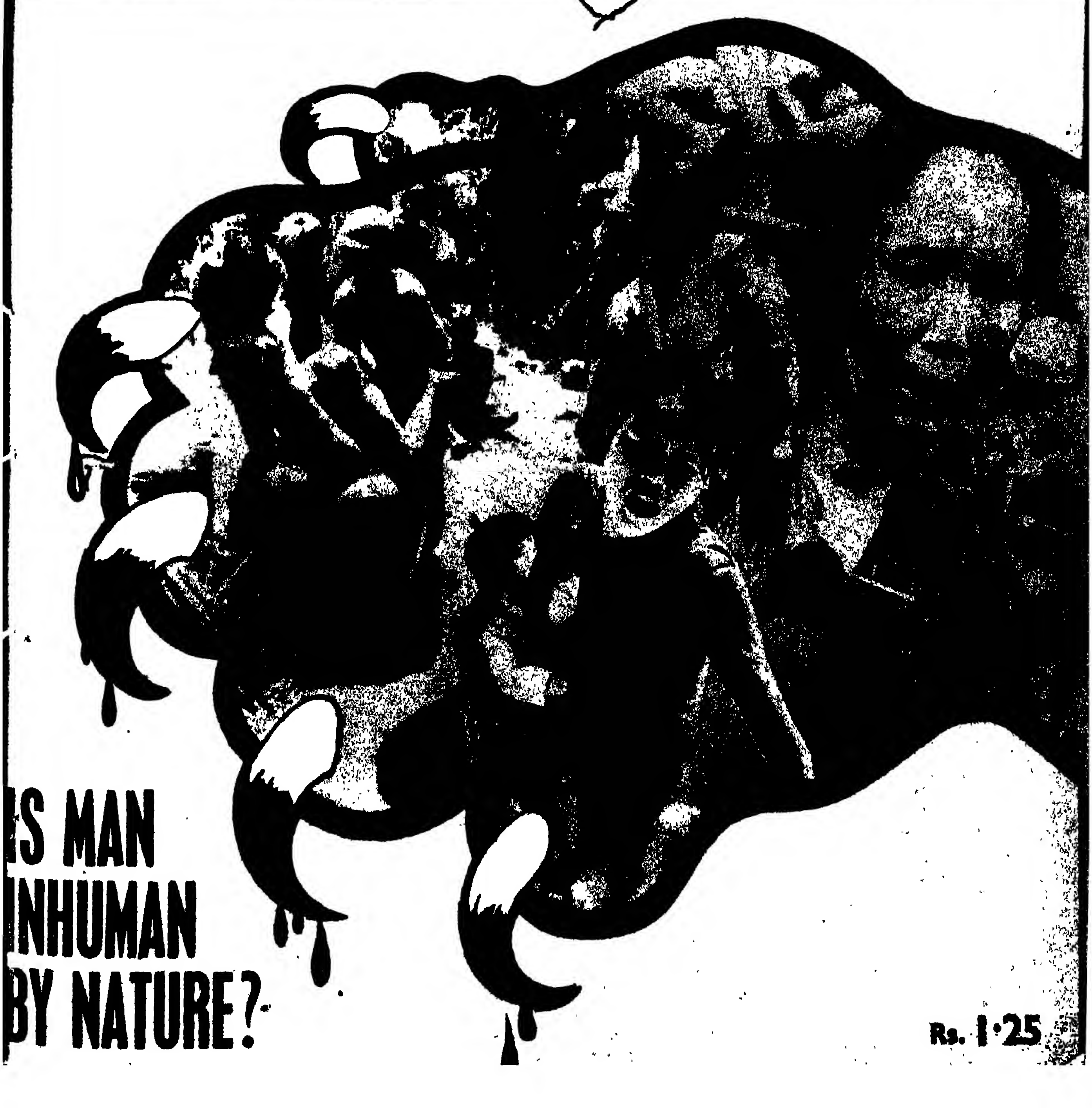
Branches & Associated Offices:
New Delhi • Calcutta • Madras • Hyderabad • Bangalore.

Dattaram-IA-3344

A TIMES OF INDIA PUBLICATION JUNE 1972

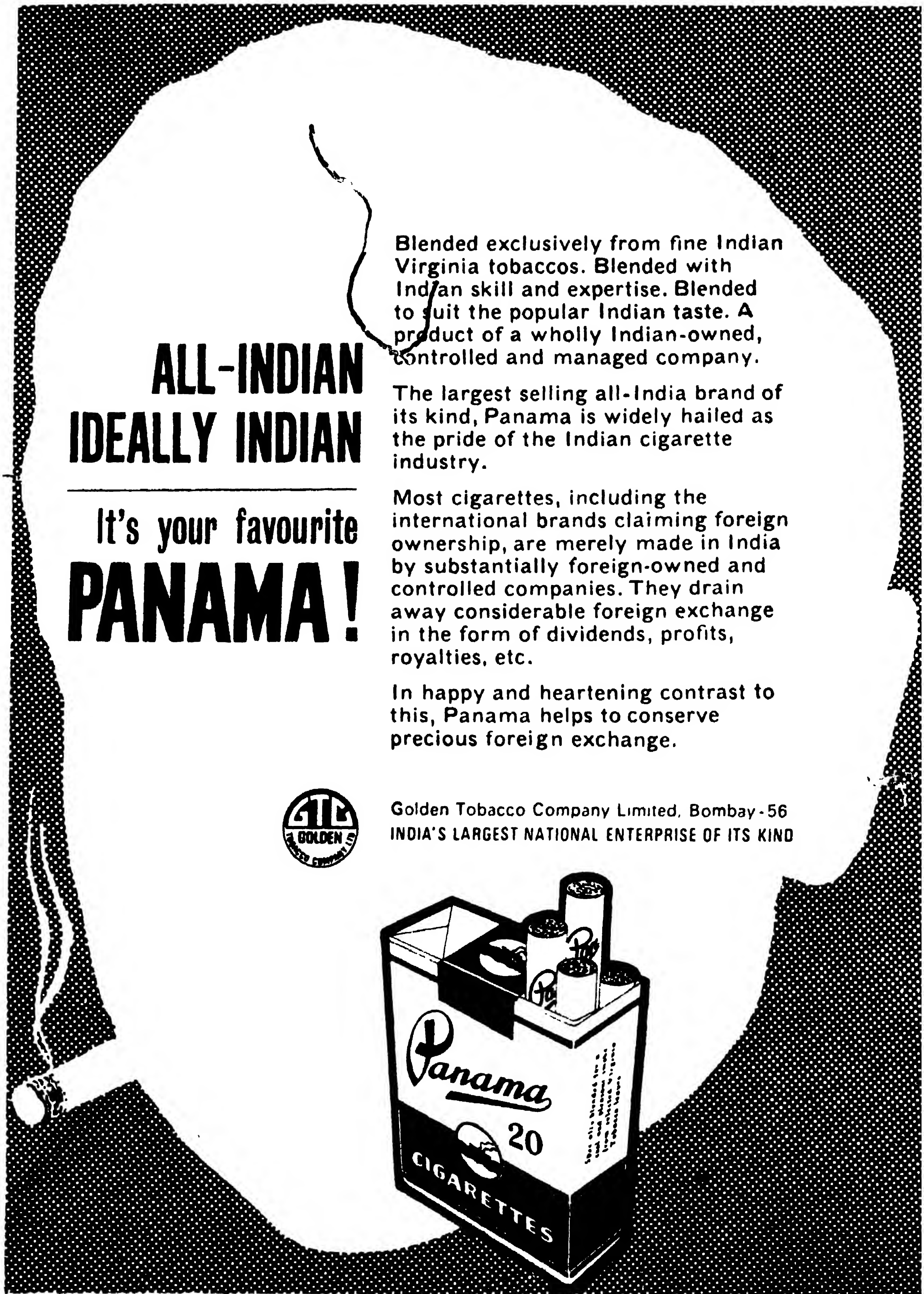
SCIENCE TODAY

FOR EVERYMAN



IS MAN INHUMAN BY NATURE?

Rs. 1·25



ALL-INDIAN
IDEALLY INDIAN
It's your favourite
PANAMA!
Blended exclusively from fine Indian Virginia tobaccos. Blended with Indian skill and expertise. Blended to suit the popular Indian taste. A product of a wholly Indian-owned, controlled and managed company.
The largest selling all-India brand of its kind, Panama is widely hailed as the pride of the Indian cigarette industry.
Most cigarettes, including the international brands claiming foreign ownership, are merely made in India by substantially foreign-owned and controlled companies. They drain away considerable foreign exchange in the form of dividends, profits, royalties, etc.
In happy and heartening contrast to this, Panama helps to conserve precious foreign exchange.
GTC GOLDEN
Golden Tobacco Company Limited, Bombay-56
INDIA'S LARGEST NATIONAL ENTERPRISE OF ITS KIND
Panama
20
CIGARETTES

GT (P)-705

Vol. 6 No. 12 June 1972

SCIENCE TODAY

Annual Subscription Rs. 12·50

Single copy: Rs. 1·25; 10p

Editor

Printed and published for the proprietors Bennett, Coleman & Co., Ltd., by Uma Shankar at the Times of India Press, Bombay, India. Delhi Office: 7, Bahadur Shah Zaffar Marg, New Delhi 1

ABOUT THE AUTHORS

H. G. SEN (*The Indomitable Blood-suckers*) is Head of the Division of Parasitology, CIBA Research Centre, at Goregaon, Bombay.

He did his MS (1958) and Ph D (1960) in parasitology from the University of Nebraska, USA, where he studied the role played by lungworms of swine (*Metastrongylus* sp.) in the transmission of swine influenza virus. Later he had advanced training in experimental therapeutics for various parasitic infections at Basle, Switzerland. In 1970, Dr. Sen succeeded in infecting hamsters with the human hookworm *Necator americanus*, opening a new area for research and facilitating the screening of various drugs against hookworms.

Dr. Sen is a Fellow of the Royal Society of Tropical Medicine and Hygiene, London.

●●

T. H. RINDANI (*Stress*) is Dean of the Seth G. S. Medical College and KEM Hospital, Bombay. Earlier he taught physiology at the T. N. Medical College, Bombay. He has worked with Prof. Hans Selye, pioneer in the study of stress, at the University of Montreal. He has several publications on the endocrinology of stress, and has served on various expert committees.

●●

LEON EISENBERG (*Is Man Inhuman by Nature?*) is Professor of Psychiatry at Harvard Medical School and Chief of Psychiatry at the Massachusetts General Hospital, Boston (USA).

●●

AWARDS & APPOINTMENTS

Dr. Y. Nayudamma, Director-General of the Council of Scientific and Industrial Research (CSIR), Dr. Jai Krishna, Vice-Chancellor, Roorkee University, and Mr. S. Visvanathan; Tata Iron and Steel Company, Jamshedpur, have won the K. L. Moudgill Awards for 1971. The awards, instituted by the Indian Standards Institution, are for contributions towards standardisation in various fields.

* * *

Carbon arcs are used in photolithography, motion picture projection, etc. So far they have been imported into India. Three scientists have now developed a process for the manufacture of carbon arcs for which they have won the National Physical Laboratory's award of merit for 1972. The scientists are : Mr. S. K. Kapur, Dr. S. S. Chari and Mr. C. L. Verma. The award carries a cash prize of Rs. 1,000 each.

In the forthcoming issues . . .

MUST SCIENTISTS BE MARTYRED ?

COCKROACHES

ZERO POPULATION GROWTH

OLYMPIC GAMES

HIMALAYAN WATERS

NEW MATHEMATICS

LETTERS

The giver takes all!

TERESA Hayter's point ("Blurs & Bright Spots," SCIENCE TODAY, April 1972) that the international financial agencies are dominated by the US and other wealthy nations is borne out by recent attempts to blackmail Chile. Chile unilaterally stopped paying interest on all foreign debts from 9 November 1971. Payment would have sliced away a clear 35 per cent of its export earnings for that year alone. Trouble came in March this year when Chile tried to negotiate fairer terms for its debts with 22 wealthy nations including the US. The Paris Club, as the rich 22 are known, rebuffed Chile, mainly at the instigation of the US. The latter, still smarting from Chile's take-over of their vast copper holdings under an "excessive profits" law, insisted that the International Monetary Fund should have a say in Chilean monetary policy before any agreement on debts.

The rich countries, of course, can teach the most ruthless private moneylender a lesson or two in the uses of "aid". In 1970, according to UN figures, the total aid received by 80 developing countries was 5,300 million dollars. In the same year, these countries paid out 2,300 million dollars as aid "servicing" charges. Very few are able to get fair terms, or squirm out of their heavy obligations. The lending governments know how to wield the big stick in upholding principles of legality and the like — as defined by them, of course. But behind governments lurk the faceless corporations and only rarely do we catch sight of their workings. One such privileged glimpse was provided recently by the US columnist Jack Anderson's "ITT disclosures".

The victim in this piece is again Chile. The International Telegraph and Telephone Corporation, the eighth largest in the US, with yearly sales of 7·3 billion dollars and interests ranging from hotels to insurance, got rattled when Salvador Allende, a Marxist, was elected Chile's President in 1970. Fearing a take-over of its 150-million-dollar investment — which earns profits of 25 per cent every year — top ITT officials urged the US government to prevent Allende's inauguration at any cost. ITT's contribution to the fun was to be 10 million dollars plus attempts to generate economic chaos and engineer a military coup. Perhaps because other US giants were apathetic, the Nixon administration turned the project down. A Chilean Congressional investigation, meanwhile, has discovered that Anaconda Co, the expropriated mine-owners, put up most of the money for a "propaganda compaign of terror" in 1970 to block Allende's election.

Latin America, long before Teresa Hayter, has been intimately familiar with the heavy American boot. The US government and US business interests have toppled uncooperative regimes, financed ambitious generals and intervened directly in Latin American affairs right through this century. The American magazine *Newsweek* ("Dollar Diplomacy, 1972 Style") reported on 10 April this year that one company alone — United Fruit — was able to manipulate governments and establish a banana empire that once encompassed 1·6 million hectares (4 million acres) from Cuba to Ecuador. Brazil, whose fortunes are closely tied up with world coffee prices, was driven to the financial brink in 1967 when it tried to export cheap, finished coffee, incurring the wrath of US coffee companies. The Americans just delayed an important international agreement on coffee prices.

But despite their unfortunate location in the back-yard of the United States, the Latin Americans are not alone in their travail. Nor is the US unique in this business. The bludgeon is wielded with varying efficiency by all rich nations. It appears to be a condition of their well-being. Retribution was swift, for instance, when Zambia decided to withhold its share of tribute in January 1970. President Kenneth Kaunda announced an intended take-over of a 51 per cent share in the nation's copper mines, owned by 25 foreign companies.

The financial sharks in major western capitals swiftly got down to business and, barely 20 months later, world copper prices had fallen from £700 per short ton to £417. When it had been Ghana's turn earlier, cocoa prices were made to fall by 300 per cent.

Noel Castelino
Bombay

Cure for leucoderma?

THOUSANDS of people in India suffer from leucoderma and the incidence of this disease is increasing. So far all treatments have proved abortive. Not even the new drugs available in the market have helped. Nor have continued blood tests, urine and other tests provided any clue. In many cases I have found that though there is a respite from the spread of the white patches for as many as 25 years, they not only reappear but new patches also crop up. On the scalp, they lead to loss of hair.

Researches so far have brought no tangible results. In the interest of the victims, particularly the girls and the youngmen whose future is blighted by this inoffensive but disfiguring disease, I feel that some intensive research is needed. Some say leucoderma is due to the malfunctioning of the liver; others say it is due to the derangement of hormones. But all this seems to be baseless and only add to the confusion.

G. C. Bhandari
Kharagpur

SCIENCE SHAPES LIFE

FRESH BUTTER AS A PRESERVE

Butter always has the tendency of going rancid, especially the home-made varieties. But now a new way of making butter-fat which is free from water has been developed with a view to improving the storeability of butter. Even after a three-year period of storage, the resultant concentrate can be used to make fresh butter, cream, or whipped cream so that it is mainly intended for exportation to countries without any dairy produce of their own. The raw material is either milk or cream, which are almost completely dehydrated by evaporation after being concentrated to about 84 per cent fat content. The first plant for making fresh butter from butter fat preserves has been set up in Singapore.

METHANOL INSTEAD OF PETROL

Petrol engines can run on other things besides petrol. Like methanol, for example. This was demonstrated in the course of experimentation at Aix-la-Chapelle Technical College, West Germany. Methanol has certain advantages over petrol — especially when it comes to the question of exhaust gas pollution. The non-pinking properties of methanol are much greater than petrol. And, since lead additives can be waived, the exhaust gases from cars running on this unconventional fuel are devoid of lead. The proportions of carbon monoxide and nitric oxide are also smaller. Lead additives are superfluous even if methanol is added to ordinary, common or garden petrol. And what's especially attractive is that motor vehicles on the road today could be converted to methanol operation without any major difficulty.

SOFTENERS IN THE FATTY TISSUES

Food chemists at Munster University, West Germany, have identified compounds which they discovered while examining residues of pest control agents in the human fatty tissues. These compounds, the polychlorinated biphenyls (PCB), have been used as coolants and insulators in electrical engineering and as softeners in the plastics and varnish industries. They had first been encountered in fish, sea-birds and birds of prey in 1967, and have been found to severely disturb the calcium metabolism. The researchers are now investigating these compounds closely to find out how they manage to invade the human body.

THE DRIFTING CONTINENTS

The Red Sea and the Gulf of Aden are moving apart slowly but surely. There is considerable evidence to show that each year they move one or two centimetres apart. That means Arabia is withdrawing from Africa. The East African rift-valley system seems to represent the first stage of a continental cleavage, though there has been no severance as yet. Geologists and geophysicists from 12 German universities are about to explore the causes in the Afar lowlands of Ethiopia with the assistance of the German Research Society. They hope to get a clearer picture of the physical structure of the Earth's crust and its substratum with the help of artificially produced seismic waves. This could permit them to decide whether sections of old continental crusts have sunk and been dissolved in lower-depth magma, or whether dry oceanic crusts of recent geological origin are involved.

AN "ATOMIC CLOCK" FOR YOU AND EVERYONE

The idea of a clock that is always right without ever being set — till now a pipe dream — has become practicable through the development of a new kind of electronic time distribution system based upon the fact that present-day broadcast and television transmitters radiate every-second pulse-coded information on the hour, minute and second of the day.

Receivers with digital circuits, running either on batteries or mains, accept the pulse, decode it,

A PLASTIC WORLD

The world is plastic not just in the rapid changes imposed by newer technologies but also largely so in materials technology. Take this filling station at Czluchow, Koszalin province, Poland. An ordinary filling station. But for one thing. It is made completely of plastic. It is one of a series of 200 similar stations being constructed in that country.

LAYING AN EGG

There's more to egg-laying than meets the eye. The problem, highlighted at a recent Royal Society Conversazione, involves engineering, genetics and behaviour. "An eggshell will crack if the local strength of the shell is less than the strength of an environmental insult to which it is exposed." To put it in simpler terms, if an eggshell is hit too hard it will break. Seems a very obvious conclusion to arrive at. But when you take into consideration the damage that results from broken shells, the conclusion takes on a new significance. In Britain, for example, eggshell cracking results in an annual loss of Rs 95 million. Seven in every hundred of the 15,000 million eggs produced annually have to be downgraded, mainly because of cracks. In 1968 the percentage was four.

Britain's Agricultural Research Council's Poultry Research Centre is trying to solve the problem. They discovered that most cracks occurred before the egg left the cage and many of these were caused because the hens stood up when laying. Drop height, an inherited characteristic varied greatly from hen to hen but was consistent for each individual hen. Like in the two photographs. They show the same hen laying eggs on different days. The hen's position and drop height are identical. This is a case for future planning. Breeders can develop hens and manufacturers develop floors that stop hurting eggs — and also stop eating into bank balances.

and show it visually through the medium of a numerical indicating device. The exactitude of the time indicated corresponds to that of an atomic clock. Even running continuously over lengthy periods of time, this "time receiver," which can be manufactured cheaply as a normal consumer article so that it will be within the reach of everyone's pocket, is extraordinarily insensitive to disturbances.

AIR—A STATISTICIAN'S NOTEBOOK

They have been busy again — the statisticians. And this time the focus of their exercises in numerics is All India Radio. Take some of their conclusions: AIR broadcasts 700 hours daily. Of these, 350 hours are devoted to music, 157 to news and 234 to talks, discussions, plays, features and programmes for specialised groups. AIR has 39 principal broadcasting stations and 29 auxiliary centres. The Vividh Bharati programme runs into 360 hours a day. Every day AIR broadcasts 230 news bulletins in 31 Indian and foreign languages. Of these, 83 bulletins in 18 languages are broadcast from Delhi, 92 bulletins in 18 languages and 33 tribal dialects from regional stations and 55 bulletins in 25 languages on the external services for overseas listeners.

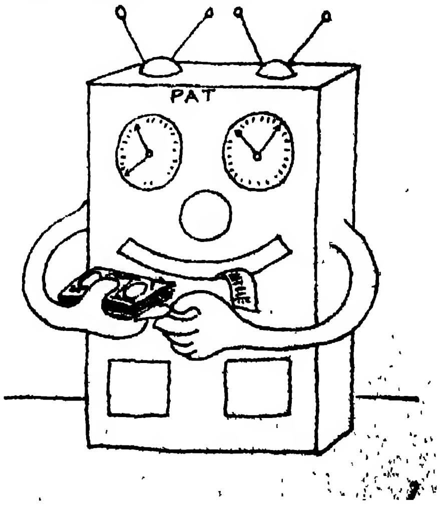
For home services, AIR broadcasts programmes in 20 principal languages, 22 dialects and 91 tribal languages. In external services, programmes are broadcast all over the world in 24 languages. If all this is true then radio seems to be really serving its purpose. But, then the Indian population stands at over 500 million today.

A MONEY-MACHINE

PAT is not just the hero of a series of not-so-genteel jokes. PAT is also a machine — "People's Automatic Teller". A bank in Philadelphia, USA, is employing PAT to streamline its services. PAT hands out money to customers and is capable of making other transactions as well.

The machine responds to a special band card issued to the customer. The customer inserts the card, punches numbered buttons designating his account, and can receive up to $ 50 (Rs. 370) in cash or make a deposit in his account. PAT can also deal with loan payments or transfer funds from one account to another.

The automated teller functions around the clock. It is capable of handling 500 transactions after which it must be restocked with money and serviced. This machine will prove useful not just in banks but in supermarkets, large shopping centres and other areas of high customer traffic.



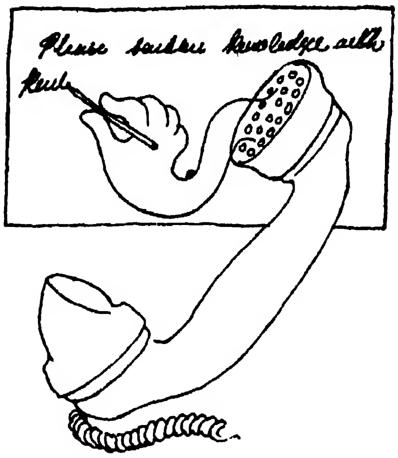
WRITING BY TELEPHONE

Telephone lines are normally meant to carry conversations. But scientists in America have worked out a system whereby these lines can also transmit handwriting. They've christened the system the "remote blackboard". With it, one can write or draw diagrams or sketches in one location so that they are reproduced almost instantaneously in another location.

If used together with a loudspeaker-equipped telephone, the system could permit a speaker at his home or office to deliver an illustrated lecture to an audience in a remote place or a teacher could instruct students in a distant classroom.

To operate the system, the user attaches his writing instrument — pen, pencil, stylus or chalk — to a "location indicator". This is a small device which, together with related apparatus, allows electronic sensing of all movements made by the writing instrument on the writing surface and automatically encodes the handwriting motions into electronic "bits" of information that can be transmitted over telephone lines. The user can write or draw in his normal manner and at his usual speed.

At the receiving end, the bits of information are translated and recorded on a special self-developing, photosensitive film for instantaneous projection on a large viewing screen.



The image is displayed almost simultaneously with the writing so that there is no noticeable delay between the speech and the picture for the audience. The film can be stored for future viewing if desired.

"VACCINATING" AGAINST OPERATION THEATRE INFECTION

Far too many patients die from post-operative infection, especially the older ones. In fact, in the past 40 years, the number of such deaths from infection has increased. Stringent hygienic measures in clinics can effectively assist prevention. But absolute sterility just cannot be obtained. This is why the endogenous defence system must be supported. Studies made at Giessen and Marburg in West Germany, on older patients who had undergone biliary and gastric surgery, have revealed that post-operative injections of antibody concentrates can reduce the rate of wound infection from 22·8 to 7·7 per cent.

USING LASERS TO MEASURE TEMPERATURE

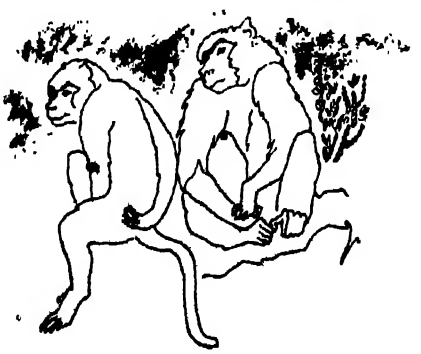
When a ray of light passes through zones of varying temperature, it is deflected towards the lowest temperature. This phenomenon is, incidentally, the basis of mirages. If the degree of deflection of a laser beam, which scans the vicinity of the arc at various points, is measured, the temperature distribution can be qualitatively defined. A German firm has built just one such temperature-sensing laser device. The process is workable up to a few thousand degrees centigrade.

THOSE POLLUTED BABOONS — AND HUMANS

The club is fast losing its exclusiveness. Plants, fishes, animals, eggs and even human beings have been inducted into its dismal atmosphere. And now it is the baboons of the distant jungles of Africa. They have joined the penguins of the Antarctic in that they too carry residual DDT in their bodies.

For those who think pesticidal residues only plague the inhabitants of highly industrialised nations, here is an eye opener. People in Kenya have been found to be carrying residues of DDT, Dieldrin and BHC. In fact, the Kenyans have more of these than the Eskimos of Alaska. While Eskimos show an average of three parts per million, Kenyans in the 25-to-40-years age group live with 4·6 parts per million.

Besides, ecologists hold out further threats. They say soil erosion will soon make the mountain ranges there uninhabitable. Experts from 12 African countries pointed out that Africa's pollution plague has been engendered by unwise land use practices — springing largely from the ignorance of the users.



THE HEART OF THE MATTER

In a distant Latvian resort town called Jurmala, doctors are pioneering new methods for diagnosing and treating heart diseases. One of these is biotelemetry. In this method an organism's vital functions are registered from a distance; functions like the biocurrents of the brain and the work of the heart.

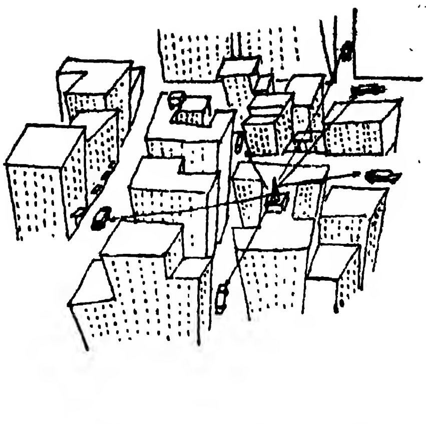
Doctors can keep a tab on a patient's heart from a distance of up to one mile (1·6 km). Special sensors fastened to a patient's chest pick up the biopotentials emanating from the heart. They are then fed to a bioamplifier of a portable radio transmitter, also carried by the patient. From there radio signals reach a laboratory radio centre and an oscillograph screen. Two-way communications are maintained between the patient and his doctor.

This method helps doctors ascertain with greater precision the patient's condition during walking, running and other stresses.

Innumerable experiments have shown that a physical load such as running is beneficial to the heart, provided it is done according to a programme drawn up by specialists. At the beginning of the course, heart patients had a rapid pulse when engaged in physical effort. By the end, at the same physical stress, the heartbeat became nearer to normal. This physical stress programme is combined with traditional methods of treatment.

HELPING THE POLICE

In Nuremberg, scientists have solved a problem that has probably occupied the attention of the police throughout the world. A newly developed direction-finding apparatus has, for the first time, made it possible for the despatcher at a patrol car centre to oversee at any given moment, on a display, the position of every car under



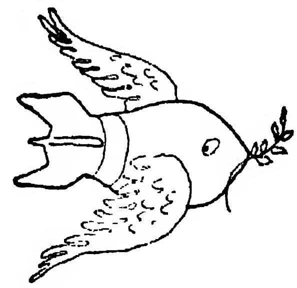
his direction. Wireless DFing amongst the sea of houses in a large city is difficult because the straight propagation of electromagnetic waves is prevented in built-in areas with the result that delays occur and measurements are distorted. In the new apparatus, a digital process computer evaluates the coordinates received, and is so programmed that it can identify false measurements immediately, reject them, and process only the correct values.

INDIA PREPARES FOR THE "PEACE BOMB"

Will India enter the nuclear club with an underground explosion this year? The twentyfifth anniversary of her independence this August may well be the occasion for her to do so. Early last month, the Defence Minister Mr. Jagjivan Ram announced in Parliament that India might explode nuclear bombs underground for peaceful purposes. The Atomic Energy Commission, he said, was studying the technology needed. He did not say if the study included simulation techniques.

In October 1971, Science Today had published a study of the economic and technological advantages of the " peace bomb ", at a time when the world's supply of easily available resources like ores and fuel are fast dwindling and prices are shooting up. An increasingly major share of these go to the advanced, industrialised countries. There is a wide gap in the per capita consumption of raw materials between industrialised countries and developing countries. In developing countries which have also a vastly higher population growing at a fast rate, industrialisation has barely begun and to raise their living standards they will need a lot more natural resources. To meet their future needs, they must either pay a heavy price in imports, or let their growth suffer. In India, this occurred in the mid-sixties, following shortages of non-ferrous metals. The choices in such a situation are to either find new materials, like when aluminium replaced copper, or use modern technology to exploit available resources economically.

This is where nuclear explosives have a definite edge over



conventional methods. Nuclear explosives cost ten times less than the conventional methods. Besides, the yields are much higher. India can beneficially use the peace bomb to extract its low-grade copper ores and oil, to build underground storages for oil and gas and water reservoirs in arid regions in Rajasthan and Gujarat. The " multiplier " effect of the subsequent industrial opportunities can, in fact, boost the country's economy.

I have been disowned...!

His body was found by his son the next morning. He had hanged himself the previous night from the ceiling fan. He was young. He was described as a brilliant agronomist. He had gone to work on the day of his death. But according to the police he had not eaten since the day before. Two days earlier, he was told a senior post which he had applied for had been given to a junior person. Before he died, he had written a letter to Dr. M. S. Swaminathan, Director-General of the ICAR, describing the reasons for his suicide. A copy of his letter, which was sent to us by his brother, is reproduced below. The dotted portions included certain names which we have deleted for reasons of decorum.

My dear Dr. Swaminathan,

5-5-72

It has become impossible for me to bear the happenings around me in the recent past:

1. It is too much of a struggle to get a better opportunity. As I had indicated to you on 3-5-72, I have been disowned by crops (breeding) men as well as by agronomy men in authority.
2. Whenever it suits some the seniority counts in the same line. At other times, seniority, contributions, basic qualifications, capacity to inspire intelligent young scientists etc, are completely ignored. Eg. the appointment of .... [the] Head of the Division of Agronomy, selection of .... [the] Professor of Agronomy (men with qualifications in plant physiology and soil science).
3. Head of the division and/or Professor could kill the incentives of section officer in the following way (as it happened to me) :

i) Not admitting him to PG teaching for a long time.

ii) Not giving him students.

iii) Supporting Research Assistants, Senior Research Assistants, Fieldmen etc against the section officer in indiscipline, failures to do the duties properly, putting them with dual authority, etc. I was not given ad hoc appointment to my present post when nobody else senior to me had any experience on maize. No ad hoc appointment as Professor because I would get it.

iv) Creating such an atmosphere that section officer is always to be blamed even when he is doing everything in the interest of work.

v) Section officer could not complain; else the matter will be directed against him. To quote Dr. Bains, " The subordinates will put false charges against you and you would not be able to stop them or correct them. "

vi) A lot of unscientific data are collected and passed on to you to fit in your line of thinking; eg in relay cropping very large sized seed potato was used to show high yields. Who will know besides some persons in agronomy that it is highly uneconomical to grow? Why is it that so much publicised Baisakh Moong did not prove successful in national demonstration? Why is it that so much praised work with slow-release N. fert. or nitrification inhibitors did not find experimental verification anywhere else in the country?

vii) A person with ideas and constructive scientific critic is always victimised whenever it comes to promotion or getting importance. Even in the achievement audit reports the contributions made by the section as well as programme of future work were changed so that they do not appear outstanding.

viii) Administrative bottlenecks are so many and are often humiliating.

ix) Director or Director-General seldom likes to hear complaints against Head of the Division or Professor.

x) Mediocre people are also recruited in preference to candidates with experience, energy, and drive because they have tact to keep the higher authorities close to them by fair or foul means; eg ....

I think the time has come again that a scientist will have to sacrifice his life in disgust so that other scientists may get proper treatment.

May I bid you goodbye and many more years of dedicated life? I have only one request to make — you may kindly guard the interest of the persons dedicated to work with intelligence.

........., myself [and others] are struggling hard against heavy onslaught — mentally as well as administratively. You may be supporting mediocres and pseudo-agronomists at the expense of intelligent agronomists.

Wishing you all the best,

Yours sincerely,
Sd.
V. C. Shah

FROM OUR SPECIAL CORRESPONDENT

NEW DELHI, May 10. The Union Government is considering the question of constituting a special wing in the UPSC for recruiting scientific personnel for various institutions devoted to science and scientific research in the country.

Vinod C. Shah. Age 39. *Born in Chorvad, Junagadh district, Gujarat. Married. Two Children. Studied at the agricultural college at Anand. MSc in agronomy. Went to the USA, PhD in maize breeding from Wisconsin University. Returned to India in* 1960. *Did some work for the Rockefeller Foundation, then joined the Indian Agricultural Research Institute as a pool officer. Last year, he became the principal investigator and associate project coordinator of the maize improvement scheme. Died by suicide on* 4 *May.*

WHY is it that everything we do — be it a reform or an innovation — seems to be done only as an afterthought? Like adopting a technology only after a precedent has been set up elsewhere? Or adopting a change only after we have been shocked into an awareness of the ills of a system by a loss, a death maybe?

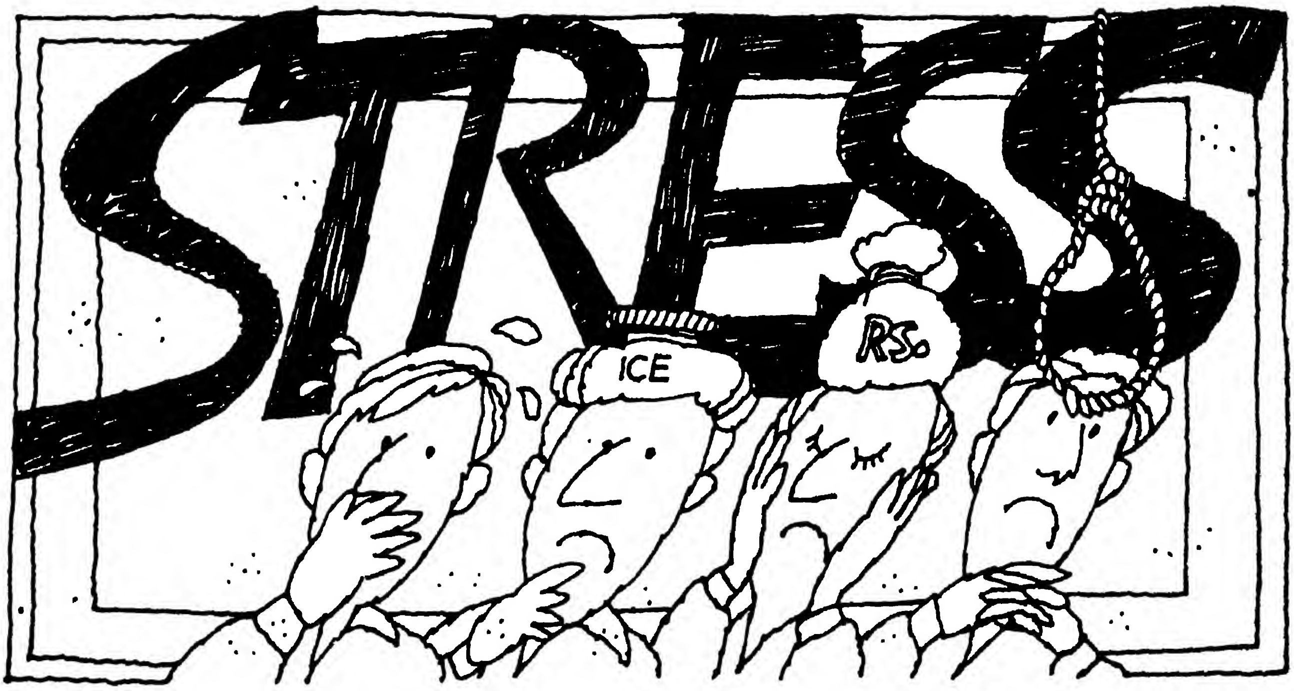
We have lost brilliant scientists and called it "brain drain". We have denied inventors every opportunity and shrugged it off when outsiders noticed them and took away the ideas. Yet young scientists join our laboratories. Many come back from abroad giving up lucrative positions. The term patriotism smacks of bombast; let's call it having roots in the soil. In return, what they ask for is minimal freedom to do their job well and a few pats on the back when the job is well done. Is that too much to ask?

There will be enquiries. Maybe, the IARI's selection procedures will be reviewed; maybe some scapegoats will be sacrificed. But the malady is not just in one institute. It pervades the whole organisation of science in this country, and it emanates from the goallessness of our national effort (see SCIENCE TODAY, November 1971, p. 43). Our every national or semi-national laboratory is infected with the bureaucratic virus. Scientific norms of free discussions and relentless reviewings have given place to submissive adjustments with hierarchical tyranny. Talent is stifled, merit ignored, and inventiveness chiselled off in the name of departmental discipline. And nobody seems to care, not even those who decide things at the top, or those who administer. Administration must never be science's master, but a helpful aid. One cannot wish away bureaucracy because that would be a utopian fantasy. But one can wish for honesty and sensitivity — these are within the human reach.

More than a decade back, M. M. Suri had invented a transmission system for diesel-electric locomotives. The process is now a profitable property of a West German firm, not the Indian Railways. Maybe the same fate awaits I. K. Bharati's direct-reduction process of steel-making. These things need not happen; the Suris and the Bharatis need not bang heads against walls, the Khoranas need not leave for other shores, the Vinod Shahs need not die. ■■


A DREAM CAME
TRUE
Shakti
Topstyle Suitings • Shirtings • Sarees
SHREE SHAKTI MILLS LIMITED, BOMBAY. THE PODAR GROUP

High blood pressure, heart disease, hypertension, diabetes! In the heartlands of Africa where civilisation is still a distant tune, these diseases hardly occur, while in the developed world their incidence is high enough to be shocking. Today medical science has discovered behind these "diseases of progress" a mysterious ubiquitous phenomenon called



T. H. RINDANI

THE human body, like every other object on earth, likes to live in equilibrium. Temperature, light, sound, food, the state of the mind — every thing must be right to the most comfortable magnitude. If not, if the equilibrium is lost, the body's defences start restoring the equilibrium. That may not be an easy task, though.

In fact, the term came from the physical sciences where stress is defined as the sum of all forces which act against a resistance. And as in a piece of metal where the changes brought about by a force need have nothing to do with the *nature* of the force, the body too reacts similarly irrespective of whether it is subjected to cold or heat, excessive light or darkness, noise, starvation or overeating. In other words, the changes are non-specific.

The concept of stress and strain was initially introduced by the psychiatrists, to describe mental tension. Then it was called " nervous stress and strain ". Today the concept includes everything that disturbs the body mechanism. Again, in the early days, stress meant only those disturbances that caused damage. Later, it was seen that similar changes occurred in the body even when the forces were not harmful. The body's response to external stimuli is so sensitive that even mild environmental variation set the defence mechanisms working. The defence is in adaptability which is the key to survival.

Inherent in this concept is the phenomenon of what was described by the French physiologist Claude Bernard as "constancy of milieu interieur" or as "homeostasis" by Walter Cannon in the United States. Simply put, this means that for normal existence an organism is required to have constancy (no doubt, within a permissible range) of the internal fluid environment of the cells of the body. All the cells in our body are bathed by the fluid produced from our blood. This fluid acts as the environment of these cells. It is through this fluid that the cells get nutrients, oxygen, etc and throw out waste products, carbon dioxide, etc. The physical and chemical characteristics of this body fluid (or tissue fluid as it is called) like its degree of alkalinity, osmolarity, temperature, and concentration of substances like glucose, sodium chloride, etc have to remain nearly constant in spite of persistent threats of a change. This constancy is maintained by changes in the body which are called adaptive reactions.

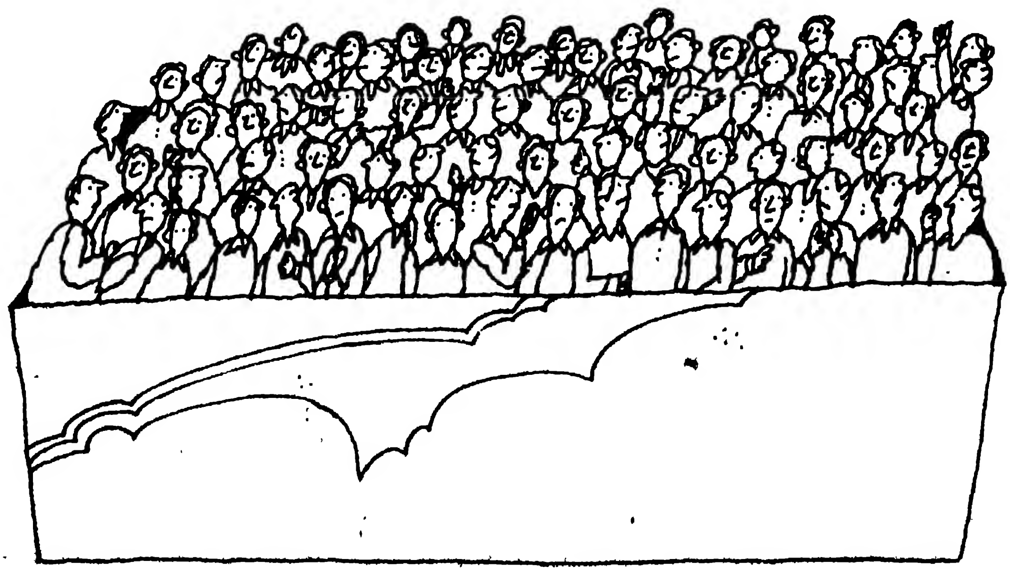
For example, after exercise, there is a shift in blood acidity; this makes a demand on both the chemical buffering systems in the blood and neurophysical mechanisms to reestablish homeostasis. Or, when the outside temperature changes, autonomic or involuntary regulatory mechanisms start working to maintain the equilibrium of the internal temperature eliminating body heat faster in a hot climate and conserving it in a cold one. Similarly, when chemical agents are ingested, or too much food is eaten, a process of elimination sets in.

Stress and disease

While Claude Bernard considered disease as arising due to inadequacy of the adaptive reactions quantitatively, it was Hans Selye who in 1950 enlarged the concept that disease is due to a failure of proper adaptive reactions both in terms of quantity and quality. In other words, we are constantly subjected to stressful situations calling for adaptive reactions which maintain a delicate balance of the body physiology — a tilt resulting in disease. Disease is thus an epiphenomenon.

Once we accept the fact that any environmental physical change or emotional situation can cause stress, the phenomenon takes on tremendous implications. One of the most challenging kinds of environmental variations is the man-made milieu, the society. Here we have aggregations of men given the task of living within a certain pattern, but the pattern is constantly changing. People interact, technology brings change, nature is being conquered day by day. Urbanisation, industrialisation, innovations for quick transport, accelerated production of goods, noise, chemical pollution, and above all the hurry and worry of life in the modern society — all these have greatly increased the demands on the body for adaptive reactions. But not all human beings can generate the same degree of adaptive reactions. The result: disease! In fact, disease can set in due to stress that is purely mental — frustration, for example. This has been seen even in animal experiments, where rats immobilised by being tied to a board and trying to free themselves unsuccessfully come up with severe stress in the form of stomach ulcers, kidney disease, etc.

In a study in Central India mentioned by Wolff it was observed that a society undergoing



a rapid cultural change towards westernisation showed an evident increase in some diseases like diarrhoea, ulcerative colitis, asthma, etc which were not related to any specific disease-producing agent but were rather stress-originated. Wolff observes. "An older and more stable culture is more likely to provide methods for dealing with accumulating tensions, dissatisfaction and conflicts. The development of frustrations and conflicts is minimised in societies where social hierarchies and one's place in life are defined, generally known and accepted and where social satisfaction is more or less static."

The proof that stress does cause diseases like heart disease, high blood pressure, diabetes, etc came from a study carried out some years ago in Central Africa and it was found that the incidence of these diseases was much less in that part of the world than in many other developed countries. Which goes to say while we are reaping the harvest of civilisation, we are paying a high price for the same. The benefits are spectacular while the damage is insidious!

The physiology of stress

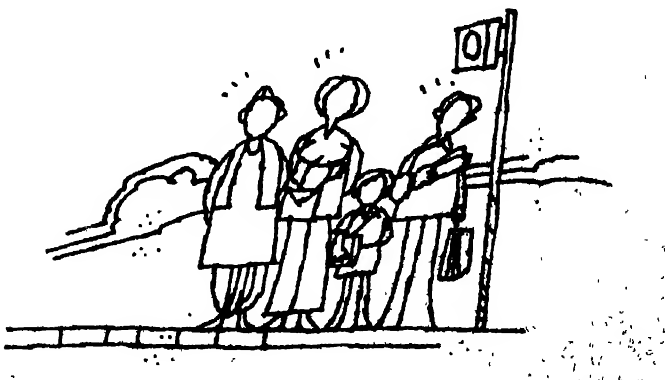
How stress manifests itself and how it brings on disease are two pertinent questions. It was Hans Selye who by a series of painstaking but perfectly logical animal experiments showed that the non-specific changes (that is, a set of bodily changes caused by any environmental alteration no matter what its nature was, like cold, hunger, frustration, forced muscular activity, etc) are mainly caused by activation of the endocrines (ductless glands) which pour out hormones into our body system. The purpose of the hormones is to produce homeostasis in spite of a change so as to enable the animal to adapt itself to the new situation. Though the nervous system too participates in these adaptive reactions, the role of the endocrines through their hormones has been studied more extensively. (The nervous system also seems to be participating in this phenomenon largely through the hormones.)

The earliest observation of Selye that set the role of the investigations in motion was the role of the crucial glands, the adrenals. Selye worked with rats. When the rats were starved, all organs of the body shrank, but the adrenals enlarged. They also became larger in several other kinds of stressful situations. When these glands were removed from the animal body before being subjected to a stress, the animal could not stand it and succumbed. However, when an extract (containing the hormones) of the adrenals was injected, the animals survived despite the removal of the gland. The adrenal gland hormones, therefore, appeared to be central in the adaptation mechanism.

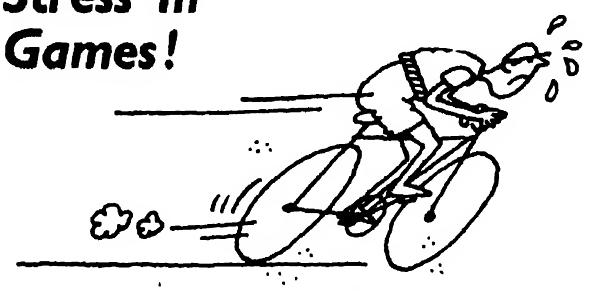
The adrenals have two functionally independent parts — an outer part called the cortex and an inner part, medulla. Hormones of the outer steroids like cortisone are the essential ones, but those of the inner part (catecholamines like adrenaline) also play an important, though transient, role in stress.

Fight or flight!

The importance of the catecholamines like adrenaline lies in what is described as the "fight or flight reaction". Whenever the body is threatened by environmental changes, it either fights out the enemy or runs away from it. Either reaction needs increased efficiency in the form of better circulation, more oxygen, better supply of a quick fuel-like glucose for muscular action (either to fight or to run away!), etc. This is provided by the action



Stress in Games!



ONE of the interesting aspects of stress is the voluntary physical activity undertaken during games. The activity by itself acts as a stressful situation, but when it forms a part of a competition there is also an added element of the keen desire of achievement of a goal with consequent joy or frustration at the end. Sports as now indulged in, particularly by the 'professionals', thus involve both physical and psychological components.

As in the case of executives employed by business houses or those handling onerous public tasks, the goals are set not by the persons striving but by others, often pitched high and at an unrealistic level. Frustration is not uncommon with failure of achievement and causes serious stress. In fact it would be prudent to curb down our 'photo-finish' competitions because the feeling of frustration gets intensified. However, challenges bring out the best and such competitions have their own part to play.

In sports, as in all kinds of stress, conditioning can play a very important part. Physical endurance can be increased, ability to withstand atmospheric differences like low oxygen pressure at high altitudes, higher environmental temperature as in tropics, etc can be achieved by graded exposure to such situations which build up the " resistance ".

When the Olympics were held in Mexico, it was realised that physical endurance of those living at sea level was not adequate at a higher altitude although they were in perfect shape at home. A period of exposure to activity at altitude raised the endurance.

We now hear of other complicating factors in our sport competitions, like use of drugs, sex testing, etc. Drugs are used to increase endurance. However, apart from being unethical and 'unsportsmanlike', there is the danger of developing addiction or what is now called as 'drug dependence'. The phenomenon of drug addiction has, in addition to the physiological component, a powerful psychic component also. In fact, addiction can be classed as a disease of adapta-

of the sympathetic nervous system and hormones, the catecholamines.

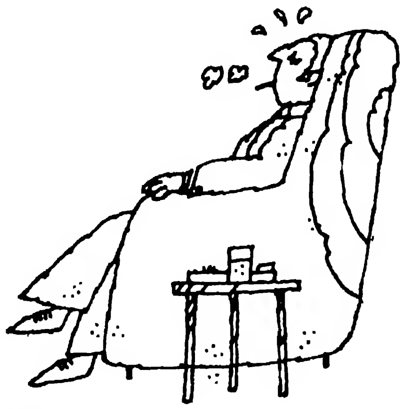
More lasting effects are however provided by the hormones of the adrenal cortex, the steroids. The adrenal cortex is controlled by the pituitary gland which in turn is under the influence of a part of the brain called hypothalamus. The net result of any environmental change is increased secretion of adrenal cortical hormones (two out of three varieties of hormones produced being distinctly important and have different kinds of actions). This is brought about either through the nervous system as in the case of factors like noise, light, etc that can act only through the nerves, or develop through chemicals acting on the brain, or the pituitary gland which in turn through its hormone acts on the adrenal cortex ordering it to produce and liberate steroid hormones. Since these hormones of the pituitary and adrenal cortex are mainly concerned in the adaptive changes, they are designated as " adaptive hormones ".

It is seen that the two varieties of adrenal cortical hormones (called glucocorticoids and mineralocorticoids due to their principal metabolic action on glucose and salts, respectively) have opposing actions at certain sites and mutually supporting actions in general. The latter enables the body in general to improve its resistance. The important sites at which the actions are antagonistic are joints and blood vessels. In these structures, the action is again on a special type of protein called collagen. This protein can lay down a protective barrier between any damaging agent and the rest of the body. Thus, for instance, if tubercle bacilli get lodged in a part of the lung they would be walled off by the increase in collagen in this area. Similarly, if some material (like blood oozing from injured capillaries) settles in a joint, the same will be surrounded by the collagen. This is thus a favourable reaction.

The increase in the settling of the collagen is inhibited by the cortisones like glucocorticoid hormone, while the locally antagonistic hormone, mineralocorticoid, promotes it. If the reaction is excessive, the joint becomes stiff and painful and the condition of arthritis

tion. Again the introduction of pre-entry testing of sex of the participants by rigid criteria has added one more dimension to the sports competitions. This could be a really substantial stress.

A somewhat similar situation occurs in affluent societies where people suffer from 'malnutrition' of overeating and stress of excessive leisure. Both these bring in a tilt of balance in a direction generally opposite to the usual one found in the poor and the physically overworked. Yet, these also act as stressful situations. Perhaps the golden mean is moderation; though difficult to practise, it is the only way to avoid harmful effects of stress.



SKETCHES BY SABIR

occurs. Thus, whenever the two antagonistic hormones fail to balance, there is disease. A series of disorders all characterised by abnormality of collagen reaction are known to be associated with stressful situations and all these are grouped as "collagen diseases". They are found to be more prevalent in developed countries and are treated by the use of the inhibitory hormone, cortisone. "Stress disorders" which include coronary heart disease, hypertension, kidney diseases, diabetes, rheumatoid arthritis, etc have thus been called diseases of adaptation (or, strictly, maladaptation) and occur with greater frequency in people who are forced to lead a life under frequent stress.

Maybe we can include in this same group the diseases caused by allergy where the host (patient) suffers from disability because of an unduly excessive reaction to foreign substances that may get entry into the body. In fact, by themselves these substances are harmless (not being able to multiply or produce poisonous substances as in the case of bacteria, or cause tissue damage as in the case of chemicals), but bodily functions are disturbed because the host tissue is oversensitive and puts up an undue hostile reaction, thereby reducing the organ functions and producing other abnormalities. Bronchial asthma is a classic example. Here the patient's respiratory efficiency is severely curtailed not by any damage caused by the causative agents but because of too much host reaction. Under such circumstances, the inhibitory hormone, cortisone, becomes useful and at times the only life-saver.

There are in fact three factors which determine adaptation: direct effect of the situation on the body (eg cold, heat, anxiety, etc), internal responses which increase tissue defence, and internal responses which stimulate tissue surrender by inhibiting defence (preventing overreaction). Resistance and adaptation depend upon a proper balance of these three factors. Like Hippocrates had said, "disease is not only suffering (pathos) but also toil (ponos) — the body's fight to restore normality". The more man steps into civilisation, the more the fight becomes necessary.

Behind all the specific changes in the body that occur in various diseases, like rash in small-pox, intestinal ulcers in typhoid fever, solidification of lungs in pneumonia, paralysis in polio, there is a backdrop of nonspecific changes of stress. It is like looking at the body "through a glass smoked by stress".

In our country a powerful and almost all pervading stressful situation is undernutrition. There is also the additional factor of largescale parasitic infestations. These alter the state of resistance and adaptation. The milieu is different from many other parts of the world. The disease pattern may therefore vary. Thus for a proper understanding of the manifestations of disease in any place one should keep this aspect of the problem in mind.

Stress of affluence

Some people believe once man has attained a state of affluence, he will have to work less and have more leisure; he will then escape stress. That is a mistaken notion. Animal experiments have shown that deviation from normal occurs in either situation — want or excess. Thus, cold as well as heat, forced activity as well as immobility, undernutrition as well as overeating, sorrow as well as joy, can cause stress. Man has no escape from it.

ROUND-UP OF RESEARCH

MOLECULAR BIOLOGY

Genetic Messenger from Silk-worm

A RESEARCH work of the most general biological significance has now been reported in the *Journal of Molecular Biology* (63,409, 14 February 1972) by two American molecular biologists belonging to the Department of Embryology, Carnegie Institution of Washington, Baltimore, Maryland. They have isolated, identified by partial sequence analysis and purified a messenger RNA species from an eukaryotic cell with the ultimate aim of investigating its synthesis and metabolism. The genetic messenger they have detected and purified directs the production of the protein silk fibroin in the cells of the posterior glands of the silk-worm *Bombyx mori.*

The larvae of this insect secrete fibroin during the terminal stages of the fifth larval instar, and at this time fibroin comprises most of the protein synthesised in the posterior silk glands. About 90 per cent of the amino-acid residues of the silk protein is known to be glycine, alanine, serine and tyrosine, with glycine comprising 45 per cent of the total. Furthermore, the glycine residues alternate predominantly with alanine and serine residues. The known sequential order of amino-acids in this protein gave the American scientists a clue as to how the genetic messenger could be purified.

It is now well-known that the genetic information of a cell is stored in DNA, a complex molecule consisting of smaller molecules called nucleotides linked in a helix to one another. Each nucleotide consists of three still smaller molecules, a sugar (deoxyribose), phosphoric acid and a nitrogen base. There are four types of nitrogen bases in DNA, viz, adenine (A), guanine (G), thymine (T), and cytosine (C) and, hence, four different types of nucleotides. These nucleotides direct the synthesis of proteins in the cell from amino-acids, of which there are some 20. Genes differ from each other only in the order in which the four nucleotide bases are arranged. Three nucleotides in sequence represent one particular amino-acid, and the order of nucleotide triplets in the DNA molecule governs the order of amino-acids in the protein chain.

In the process of protein synthesis, the DNA manufactures an intermediate molecule known as messenger RNA (m RNA). In m RNA the nucleotide bases are the same as those in the parent DNA, except that uracil (U) replaces thymine. Further, the order of nucleotides in the m RNA is the same as that in the DNA, so that m RNA conveys the genetic information carried in the parent DNA molecule.

Using the known amino-acid sequence of the silk protein, and the genetic code, i e which nucleotide triplets represent a particular amino-acid, Drs. Y. Suzuki and D. D. Brown were able to predict the composition of the silk fibroin messenger, i e the messenger should have a G + C content of at least 57 per cent and a G content of about 40 per cent.

They then labelled the silk-worm larvae for 24 hours, with radioactive phosphorus, and were able to isolate an RNA sedimenting at between 45 S and 65 S from the posterior silk glands. After purifying this RNA, the American biologists compared its base composition with the pattern predicted from the amino-acid sequence of the silk protein. They so closely matched those predicted that there was no doubt that they have unequivocally isolated and identified more than 80 per cent pure fibroin messenger RNA. By sequence analysis they found that the messenger contained 59 per cent G + C residues, 40 per cent G residues and 19 per cent C residues. They were also able to establish that glycine in the silk protein is coded by GGU and GGA, alanine by GCU and serine by UCA.

Suzuki and Brown comment that the posterior silk glands of *Bombyx mori* larvae offers many advantages to anybody intent upon unravelling the synthesis, maturation, transport and translation of a specific messenger RNA.

VISION

Astigmatism Should Get Early Attention

EYE defects like astigmatism if uncorrected in early youth, during the critical period of development of the visual system, may lead

to a permanent impairment of optical neurones (brain cells concerned with vision) in the brain. This is the conclusion of a study of human subjects with pronounced ocular astigmatism by an American opthalmologist in collaboration with two other Canadian scientists, reported in *Science* (175, 1384, 24 March 1972).

Astigmatism is a condition in which defective vision is caused by the inequality of one or more refractive surfaces, usually the lens or cornea of the eye. This defect prevents light rays from converging to a point on the retina, resulting in a blurred image. Astigmatism can be congenital or acquired, and may be corrected by appropriate compensating lenses.

The influence of early visual experiences on the arrangement of neurones in the developing brain has been strikingly demonstrated before in experiments conducted on cats and monkeys. Kittens raised in an environment from which all vertical lines were removed, when grown up, behaved as if they were completely blind to vertical lines. When the activity of the optical neurones in the brain of these kittens was measured by means of microelectrodes implanted in the brain, it was found that no cortical neurones were activated by vertical lines, though visual brain cells that react to such lines were present in the brains of the kitten at birth. It was concluded that the visual portion of the brain slowly tunes itself to the input from the retina. A logical effect of such cortical adaptation would be an unequal development of the neural connections involved in resolution of images, and, as a consequence, the resolution capacity for vertically imaged details would be reduced.

In the study now reported in *Science*, Dr. R. D. Freeman of the School of Optometry, University of California, Berkeley, USA, Dr. D. E. Mitchell of the Department of Psychology, Dalhousie University, Halifax, Nova Scotia, Canada and Dr. M. Millodot of the Ecole d'Optometric, Universite de Montreal, Montreal, Quebec, Canada, have determined the capacity to resolve lines in targets of different orientations on three groups of subjects in Berkeley, Halifax and Montreal. The subjects they selected showed marked resolution differences between vertical and horizontal lines in addition to the usual reduction observed with oblique targets. All the subjects wore correcting eye-glass lenses and the scientists carefully checked the lens corrections to insure that they were optimal under the conditions of each test.

The results of their experiments indicated that the ability to resolve horizontal or vertical lines corresponded to the nature and degree of astigmatism, in spite of the fact that all of their subjects wore correcting lenses. Further, it was found that no non-astigmatic subject showed significant vertical-horizontal resolution differences. The failure to resolve lines with equal clarity in different orientations persisted even when advanced techniques using laser-generated interference fringes were used as targets for by-passing the optics of the eye altogether.

The scientists have noted that none of their subjects with marked vertical-horizontal resolution differences had received spectacle corrections in early childhood. Hence, in the light of what is now known from experiments on cats and monkeys, they conclude that the astigmatism of the eye in their subjects during youth had permanently modified the visual cells of the brain.

SYMBIOSIS

Bacteria Aid Beetle Reproduction

MUTUAL self interest can bring together the most widely differing organisms, in a partnership known as "symbiosis" ("living together"). Among the most interesting of such cases are those of the organisms ("endosymbionts") which live within the bodies of their more complex hosts, e g the bacteria which live in the human intestine and play a vital part in digestion.

Two American entomologists belonging to the Department of Entomology, University of Wisconsin, Madison, Wisconsin, USA, have now reported in *Nature New Biology* (236, 111, 29 March 1972) a most unusual form of symbiosis. They have presented evidence that the parthenogenetic reproduction (reproduction by means of an unfertilised ovum) in the beetle *Xyleborous ferrugineus* depends on its bacterial endo-symbionts. The bacteria live in the reproductive passages of the beetle and take over the traditional role of the spermatozoon in reproduction.

This beetle produces its female progeny from fertilised eggs, whereas the male progeny arises parthenogenetically from unfertilised eggs

produced by unmated or virgin females. In many insect species like beetles, embryonic development is initiated in unfertilised eggs by means other than by sperms.

A microscopic examination by standard histological techniques of virgin and mated female beetles by Dr. B. Peleg and Dr. D. M. Norris revealed that the eggs start developing into embryos before fertilisation occurs, and bacteria are intimately associated with the nuclei of the eggs at all stages of their maturation. By isolating and culturing the bacterial symbiotes, they determined that the bacteria belonged to the genus *Staphylococcus*.

In their experiments they reared unmated female beetles for six weeks on a diet of 1·5 g of sodium benzoate to which was added an antibiotic such as chlorotetracycline HCl, streptomycin sulphate or penicillin G. potassium.

In antibiotic treated females oocytes or egg-forming cells were formed but these did not divide or mature. This is because the antibiotic had reduced the population of bacteria to levels which did not allow normal oocyte maturation and embryo development.

When the beetles, apparently sterilised from antibiotic treatment, were transferred to a fresh diet free of antibiotics, they regained normal fertility, and laid eggs. Examination of these eggs revealed that the developing embryos were associated with large populations of the endo-symbionts. This confirmed that the bacterial endo-symbionts were functionally associated in the reproduction process.

CHILD HEALTH

Why Expectant Women Shouldn't Smoke

MOTHERS who smoke after the fourth month of pregnancy run the risk of giving birth to babies which weigh some 170 g less, on an average, and which have increased chances of not surviving birth.

There is now increasing evidence to suggest that cigarette smoking is a causal agent in cancer of the lung, coronary diseases, chronic bronchitis and to a lesser extent cancer of the bladder. A number of recent studies have indicated that smoking during pregnancy results in offspring with reduced birth weight, that it also increases the mortality during late pregnancy or shortly after birth; the excess of deaths is mainly accounted for by causes associated with low birth weight. However, there have also been many studies which have contradicted the above conclusions. Two factors are responsible for these conflicting results: (1) the inadequacy of the sample studied and (2) mothers who smoked in pregnancy tend to come from a poorer social background, are older, and have had several children, with the result that lowering of birth weight and increase in mortality at birth is rather an index of a particular type of mother.

Drs. N. L. Butler and E. M. Ross of the Bristol Royal Hospital for Sick Children, Bristol, England together with Dr. H. Goldstein of the Institute of Child Health, Department of Growth and Development, London, England have now in an article in the *British Medical Journal* (2, 127, 15 April 1972) presented a study of cigarette smoking during pregnancy using a sample much larger than all the other major studies put together.

They obtained information on smoking as a special item in a questionnaire completed by midwives at the time of the delivery. The analysis considered the effects of change in the number of cigarettes smoked before pregnancy and after the end of fourth month. Allowance was also made statistically for a number of maternal variables such as social class, age, height, etc which might mediate the relation between smoking and birth weight.

The scientists find that the decrease in birth weight is really an effect of smoking during pregnancy and has nothing to do with a particular type of mother. Further, the mother's smoking habits before pregnancy and in its early months have no significant effect on the outcome for the baby. Significant harmful effects arise only among mothers who continued to smoke after the fourth month of pregnancy. In the British population studied, cigarette smoking during pregnancy increased the mortality rate by 28 per cent. Further, the birth weight was reduced on an average by 170 grams.

The doctors conclude that their results have important implications for health education. They estimate that if mothers are persuaded to give up smoking after the fourth month of pregnancy, a saving of approximately 1,500 infant lives might result each year in Britain.

ASTRO-PHYSICS

Cyanogen Clouds and Cosmic Background Radiation

THE existence of a universal background radiation having black body temperature of 2·8°K in the microwave region of the electromagnetic spectrum has been known since 1965. Measurements on this background radiation in the regions approaching the far infrared region of the spectrum (1·3 mm to 0·4 mm) a couple of years ago had, however, suggested that the background temperature may be anomalously large, around 8°K. Recent experiments are providing evidence that this is quite unlikely and one in this category is the report in *Physical Review* letters (28, 772, 20 March, 1972) by Drs. A. A. Penzias, K. B. Jefferts and R. W. Wilson of the Bell Telephone Laboratories, New Jersey, USA. They have made a direct search for the 2·64 mm line emission from interstellar clouds of cyanogen (CN) molecules.

In theory, it is possible to determine the temperature of the background radiation at 2·64 mm simply by examining the CN lines in the spectra of stars that are behind the interstellar CN clouds. It has long been known from such optical absorption lines that a considerable fraction of interstellar CN radicals is found in the first rotational level rather than the ground state, the energy difference corresponding to a wave length of 2·64 mm. Calculations suggest that this excitation could not be maintained by collisional processes in the clouds or transitions from higher levels.

In the present experiments Drs. Penzias, Jefferts and Wilson have verified the result from optical techniques by a direct measurement of the brightness temperature of the background. They have made a search for the 2·64 mm emission from a cloud of CN in the direction of the stars BD + 66° 1675 and BD + 66° 1674, about one minute of arc apart. They made their measurements using the 10·97 m. diameter microwave telescope of the National Radio Astronomy Observatory Laboratory, Kitt Peak, (Arizona, USA). The star BD + 66° 1675 has the highest concentration of CN of the stars so far studied.

The search for the 2·64 mm emission gave a negative result, indicating that the CN is in equilibrium with the background radiation, and that within the limits of the experimental errors, there is no extra excitation that should be allowed for in the determination of the background temperature. The present result thus verifies the background temperature deduced from the optical observations and supports the view that the 2·8°K black body spectrum continues without modification to shorter wave-lengths approaching the far infra-red.

METEOROLOGY

Does Decaying Vegetation Induce Rainfall?

WHAT are the natural nuclei that induce rainfall from supercooled clouds? This question remains unanswered because these nuclei constitute only a minute fraction (one in a million) of the total number of atmospheric nuclei. Further, they may be a mixture of substances whose only common property is the ability to nucleate ice. Two American scientists suggest in an article in *Nature* (236, 163, 24 March 1972) that decaying vegetation can provide the nuclei that seem vital to the rainfall process.

Since 1966 meteorologists have tried to induce artificial rainfall by seeding clouds with dry ice or silver iodide crystals. Attempts by meteorologists to induce rainfall by this process during the last two decades, however, have been frustrating.

Most of the artificial cloud seeding agents such as silver iodide are effective below a temperature range — 4° to 0°C. Dr. R. C. Schnell and Dr. G. Vali of the Department of Atmospheric Resources, University of Wyoming, Laramie, Wyoming, USA, find from laboratory experiments that the nuclei of decomposing vegetation, which they call as 'leaf-derived nuclei' (LDN) are active seeding agents at temperatures warmer than — 10°C.

According to the American meteorologists, because of the great amount of nuclei provided by decaying vegetation and the warm temperatures at which LDN are active, besides playing the role of a natural source of ice nuclei in clouds, LDN can also be used in artificial cloud seeding. Natural substances like LDN for cloud seeding would be far more preferable than the metallic substances now in use for artificial rain making.

K. A. Neelakantan

Research in brief

CULTIVATING "NAKED" VEGETAL CELLS

There are great opportunities in the offing in plant cultivation. A new enzyme technique has made it possible to conduct hereditary experiments in botany. Till now, such experiments were possible only on microorganisms and animal and human cells. If the enzyme — known as pectinase — is used to dissolve the central laminae of the cell walls, it is possible to bring about mutations. If another enzyme — cellulose — is used to remove the cell walls, the. resultant "naked" cells (protoplasts) can adsorb highly molecular substances and even larger particles. Whole plants have been successfully reproduced by blending protoplasts, says Prof. Georg Melchers of the Max Planck Institute of Biology at Tubingen, West Germany. And this makes somatogenetics — research into heredity with body cells instead of sexual cells — now feasible with plants too.

TEA LASERS

Two scientists, Drs. A. J. Alcock and M. C. Richardson of Canada's National Research Council's Division of Physic's Laser and Plasma Physics Section at Ottawa, have designed a new laser capable of generating billions of watts of power in pulses lasting less than one ten-millionth of a second.

The new laser is a new addition to a family of TEA lasers which were first invented by Canadian scientists at the Defence Research Establishment Valcartier (DREV), Valcartier, Quebec. Ever since their discovery two years back, engineers and physicists over the world have shown considerable interest in TEA lasers. These TEA (tranversely-excited atmospheric pressure) carbon dioxide lasers are characterised by their low cost, high efficiency and relative safety of radiation produced.

Such lasers will prove attractive in industrial operations like drilling, welding, cutting and machining as they generate high power. The NRC laser is believed to be the first laser capable of generating gigawatt (billions of watts) powers in pulses lasting only 50 nanoseconds (50 billionths of a second). Another advantage is that the laser is built in modular form and is easily amenable to commercial development. It is made up of a number of box-like modules, all identical, every one a complete unit.

A Canadian firm will shortly undertake the commercial development and marketing of this laser. TEA lasers are powerful enough to instantly vapourise all known materials. That means such lasers could be used to produce plasma fireballs with temperatures comparable to those on the Sun. Current research programmes in many countries are directed at studying the production of these extremely high-temperature plasmas for controlled thermonuclear fusion.

BLURS & BRIGHT SPOTS

Go slow, Green Revolution!

EVER since Alamogorado's sky had lit up with the blast of a nuclear sun, mankind has learned to live with the paradox that all progress is inevitably nihilistic. Technology's boomerang has now been noted by several disciplines, including biomedicine; many, like the ecologists, have spoken aloud. But one area that everybody believed would have to be worked at the level of maximisation was food production: one can never have too much of food, not with world population threatening to double itself by the end of the century. Yes, one can, since too much food will keep too many people alive and reproductive! The ominous warning from Stanley Johnson, a British scientist, (in the London *Times*) does have some food for thought!

Say no to the Green Revolution? After we have paid our highest tributes to its architects like Norman Borlaug (for wheat) or Robert Chandler (for rice)? After what it has done for India and Pakistan where the wheat harvest virtually doubled in six years? Or the Philippines, which from being a large importer of rice turned into a net exporter? Yes, says Stanley Johnson. His reason: " To some extent, the very success of the Green Revolution carries the threat of failure. The plant breeder is engaged in a race against time. The spread of a new variety may produce a more favourable ecology for some pest or pathogen; it may also drive out a large number of indigenous varieties, causing a loss of valuable genetic material, which may be precisely what the plant breeder needs if he is to keep ahead of such pests."

The Green Revolution has kept people alive, and breeding, who might otherwise have died. The population base will expand until the saturation point is reached; " when the food-population 'crunch' comes, there will be more hundreds of millions ready to die. The triumph of men like Borlaug and Chandler will in this case seem hollow indeed, " says Mr. Johnson.

So we have another perfect ethical dilemma. Who will decide how many must die now so that how many more may be saved later? Can the State, excited by its humanitarian ambitions, ignore the future? Borlaug, we remember, had himself once talked about a " breathing space " theory of the Green Revolution. But that may be difficult to practice due to political imperatives. The other way out, in fact the only one, is ceaseless vigil on the front of population control.

... and now geophysical warfare!

THIS may turn out to be human civilisation's biggest joke yet! Nations who, by virtue of their enormous development in science and technology, could act with the benevolence of a god towards other less fortunate cohabitors on this earth, have in fact chosen to acquire the unscrupulousness that legend attributes to the inhabitants of Mount Olympus. Armaments research in the United States is a case in point.

First with nuclear weapons, their inventiveness has been matched by an enviable success record. Electronic sensors, chemical agents, gas warfare, and now — despite all those SALT talks and biological warfare treaties where their delegates' solemn faces glowed with the burden of carrying humanity's cross — comes the news of Nile Blue, code name for a US project for research into weather modification for military purposes. The revelation comes from Dan Greenberg's *Science and Government Report.*

This is " geophysical warfare ". As if weapons and inactivating agents were not enough, now you can play Zeus and send rain and thunder from the sky; all you have to do is seed the clouds. (Some European newspapers report it has already been done in Viet Nam, over the long, winding Ho Chi Minh Trail.) After rain, bring thunder, after thunder, churn the earth! Earthquakes, tidal waves, and " ecologically disruptive temperature alterations ". The techniques have been described, albeit speculatively, in a piece in a book *Unless Peace Comes* written by Gordon McDonald (the book edited by Nigel Calder was published by Penguin Press, 1968).

(Continued on page 25)

Are the Marine Food Resources Infinite?

V. S. Bhatt

IN the past decade there have been considerable discussions about the future role of oceans in providing food for the world's hungry millions. Several theoretical calculations have been attempted to determine the magnitude of such needs. According to a recent estimate, the total annual production of fish and allied fishery products which form the ultimate stage of what is called the food chain in the sea would be approximately 200 million tons. Of this, up to 67·8 million tons were exploited during 1970 and a lot more could perhaps be produced in the years to come. The possibilities of raising yield are stated to be more in comparatively less exploited areas such as the Indian Ocean. The previous known fishery exploitation in the Indian Ocean was to the tune of about 2·5 million tons; this is expected to be raised to over 20 million tons.

However, the present state of world fishery indicates that the resources of the oceans are not inexhaustible. This has been specially felt in several heavily exploited fishing grounds of the world. According to the FAO Director General, Mr. A. Boerma, world fishery is passing through a critical phase. The last two decades have seen rapid development of fishing technology which is changing day by day. In the last decade the production has more than doubled from 27 million tons in 1958 to 63 million tons in 1969. "At the beginning of this period, all fish stocks outside the North Atlantic and the North Pacific were under-exploited or not exploited at all. Now there are few stocks of the types of fish readily caught and marketed, which are not heavily exploited."

Overexploitation

The pinch of overexploitation has been felt in several corners of the world — the worst in the case of Antarctic whales. Consequently, Norway, once the pioneer of whaling in the Antarctic, has sold its last whaling factory ship, *Komos 4*, to Japan. The USA also ended its 300 years old whaling operations and no whaling ships will be operating this year from US coasts. The whale quota in the Antarctic has been considerably reduced to protect the waning species. Today, only the USSR and Japan send their whaling fleets to the southern oceans.

Or, take the Canadian Atlantic Coast herring landings. There is increasing evidence that resources worth about 12 million a year to Canadian fishermen are being seriously overfished by leading fishing nations. The catch is feared to have declined by 50 to 56 per cent. As a result several small processing firms on the East Coast of Canada are going out of business. In the late 1960s the heavy catch of British Columbia had collapsed completely and complete fishing ban was imposed in 1968 for recovery of the stocks.

Even the waters off the southwest coast of India are showing signs of overfishing for shrimps, as has been indicated by a considerable fall in the per capita yield in the recent catches as compared to those of the past years. Although, there is an enormous scope of finding new and richer resources in the waters of the Indian west coast, in the face of indiscriminate and uncontrolled exploitation, a situation leading to such crises in time to come may not be ruled out completely. It should, therefore, be kept in mind that, scientific studies towards introducing conservation measures form an urgent necessity for a proper management of the stocks.

The indiscriminate exploitation of fish by the fish meal factory ships has been frequently pointed out. Recently, the delegate of Poland in the 6th meeting of the FAO Committee of Fisheries objected to the catches being used for meal, when industrial and food fishermen were competing for the same fish of the same species in the same areas. If continued, he observed, the uncontrollable expansions of industrial operations would drive food fishing fleets out of the grounds.

Territorial extensions

The problem of overfishing and depletion of fish stocks by fishing fleets of various countries has caused great concern in several coastal states who have now extended their territorial limits against the existing recommendation of

the International Laws of the Sea. For example, South American coastal states have already declared 320 kilometres as their territorial limits, thus banning any International Fishing Operations within these limits. Recently, the government of Iceland announced that her territorial waters would be extended to 80 km from the shoreline not later than 1 September, 1972. Giving reasons for such a move, Mr. Einar Agustsson, the Foreign Minister of Iceland, has said, " there are clear signs that the coastal waters of Iceland are seriously being overfished. Total catches of haddock and herring have fallen and now the cod is threatened. With the world's great distant fleets poised to move from the exhausted Barents Sea, the irreparable ruin of Icelandic fish stocks is imminent ". The problem of overexploitation by distant fleet is seriously affecting Iceland's economy since almost a fifth of its gross national product is derived from fishing industries and marine products make up between 80 to 90 per cent of the country's export. The failure of fish catch has resulted in the fall of the nation's income. The present trend of territorial extension by the coastal states is leading towards the gradual disappearance of high seas due to its divisions among the coastal states and is causing serious problem to international high sea fishing.

According to the FAO report (*The State of Food Agriculture in 1971*), " fishery industries are in difficulty not only because of overfishing of traditionally exploited resources but also because of rapid technical obsolecence of fishing equipment, high debt burdens and interest charges, rising labour cost, lack of skilled skippers and other costs of impared efficiency ". Effects of marine pollution which hamper the replenishment and maintenance of resources have also been causing growing concern.

The way out

In view of the above problems it is quite apparent that the fishery resources of the ocean are not infinite and cannot be relied upon indefinitely merely on the basis of an indiscriminate hunting policy. The present problems of overexploitation, territorial extensions by coastal states, and marine pollution, etc, if unchecked, may pose a serious threat to the world fisheries. If this state continues, according to Dr. Arvid Pardo, Malta's Ambassador to the United Nations, " long before 1985 conditions in the marine environment will be in such a mess and economic wastes and resources exploitation will have reached such horrific height that targets confidently advanced, for instance, for the production of living resources may be found incapable of achievement ". The existing International Law of the Sea, he said, was designed a long time ago and fell short of providing solution to these problems arising today.

In the days when the various conventions in the law of the sea were promulgated, the ocean and its resources were considered to be infinite and inexhaustible. These have been proved wrong today by the tremendous growth and development in science and technology. FAO experts believe that there is a need for an international order or agency under the UN to look into these problems. According to Mr. Boerma, the FAO and its department of fishery have an important part to play in this work. The functions of the agency should be to formulate new regulations in the high seas beyond the territorial waters for the rational exploitation, management and conservation and to see to their effective enforcement. The regulations will keep in view the vital interests of the coastal states dependent on the marine resources. The agency should be endowed with powers of administration, management and regulations that have not been granted to any international organisation so far. This is necessary because of the fact that the conservation steps suggested by some of the existing international organisations were never implemented effectively.

[Dr. Bhatt is a scientist with the National Institute of Oceanography at Panaji, Goa.]

Blurs & Bright Spots *(Continued from page 23)*

McDonald is a former member of the US President's Science Advisory Committee and is now working with the Council on Environmental Quality. Among the techniques he talks about is creating a temporary " hole " in the ozone layer over a target area and releasing the full force of solar ultraviolet radiation which would be fatal to all life. Earthquakes can be triggered if the rock-layer pattern is known accurately — a small distant explosion would do. Phased explosions could be used to generate " guided tidal waves ".

The United States, it is believed, permits the highest degree of public self-criticism within its shores. But the loud critics notwithstanding, the Defence Department has a research budget of $ 3 million for 1972. Three million dollars to acquire Zeus' thunder? What price then is man's freedom? ■■

"We produce several thousand agricultural graduates and post-graduates every year. Yet why did the per capita productivity in our agriculture remain practically stagnant during the last decade? While the present is rightly referred to as the age of science, what is the vision of our scientists about the

Agriculture

M. S. SWAMINATHAN

IF all the scientific breakthroughs now being accomplished in various agricultural universities and institutes are to be converted into production advances, we need a radical restructuring of our educational techniques and aims. The new technology itself is size-neutral, i e, it can be adopted by all farmers irrespective of the size of their holding if a coordinated supply of knowledge and the physical inputs prescribed by scientists is ensured. I would like to take each age group separately and indicate how we can generate a new educational chain which can help to move fast the wheel of economic progress.

Pre-primary and primary education. In the first year of life, the young human being learns more than he ever does in any other year of his life. Starting from almost nothing, the child learns to move, walk and communicate within the short space of twelve months. Learning proceeds rapidly during the next few years, but the rate of growth gradually slows down. The first five years are the period of maximum intellectual development (80 per cent is completed by this time). At this age, education is through play. Play may be defined as an activity having no end outside itself and undertaken for its own sake, unlike work which has to be oriented towards a defined objective. This is the real distinction between work and play, and not that play is pleasurable or useless while work is not.

At the primary level, play gradually turns into work in two ways. First, the activity is undertaken with a definite objective in view — there is an aim to be achieved and a task to be done. Secondly, the tasks are no longer freely selected by the child, but are socially determined and in practice set by the teacher.

The book-centred village school which turns away from the reality of the environment and denies the student an opportunity to gain competence in real tasks is responsible for our present difficulty in linking education and productivity. In village schools, children who are undeniably competent in the tasks of daily life are treated by teachers as incompetent idiots who fail to deal effectively with certain limited kinds of skills and operations. What a broad field could be opened up if these daily tasks were themselves used as instruments of education.

With simple tools such as soil testing kits and nutritional seed kits, a whole new world can be opened up for the school children in villages. The study of birds, the identification of weeds, the detection of alkalinity, the harvesting of water and the prevention of damage by rats and pests both in the field and in the store rooms would all have immense educational and practical value. The equipment needed for such studies is simple and inexpensive and mostly requires only a well-informed teacher who does not curb the questioning mind and is not afraid of long walks. With a little training this is one field where all university students of agriculture and science can render great service.

Secondary education. It is well known that the percentage of school dropouts is very high in rural areas. Most of these occur in classes I and II. It is estimated that a child who successfully completes class II has a 50 per cent chance of completing high school. The attitude of a farmer to the education of his children is conditioned by (*a*) his interest in having an additional pair of hands to help him in farm work, or (*b*) his fear that the education of children may lead to his being abandoned on the farm, or (*c*) his desire that his sons should not have to struggle with unremitting work and uncertain income as he had done in his life and that they should become "white-collar" workers. All these attitudes unfortunately hinder the healthy development of the educational career of rural children. How can a change in outlook be accomplished?

Agriculture as a subject is taught in secondary schools in certain parts of the country where the

agriculture of tomorrow?" The questions were posed by the Director-General of the Indian Council of Agricultural Research, Dr. M. S. Swaminathan in his convocation address at the UP Institute of Agricultural Sciences, Kanpur. His own answer which appears here is extracted from the convocation address

& Education

boards of secondary education have accepted it as one of the optional groups of subjects for the high school examination. Agriculture is also accepted as one of the basic crafts in some of the basic and post-basic schools in the country but is less widely used than desirable. Agriculture as taught and practised now suffers from two defects, which are found at both ends of the spectrum. First, it is not related to the daily life, activities, interests, needs and economic benefit of the surrounding community and secondly, it is technologically out of date. The main reason for this is that the teachers concerned are not equipped with adequate subject matter content at the appropriate technological level, and they have not been adequately trained to correlate the work with the immediate environmental needs and resources. A new outlook for agricultural education at school level would, therefore, imply that we set ourselves some of the following aims:

(*a*) To make primary and secondary education in the rural areas more meaningful and relevant to daily life by relating agriculture to it properly.

(*b*) To increase the component of practical work, including manual labour, in education.

(*c*) To introduce programmes which can be of direct economic benefit to students, which will enable students to earn while they learn.

(*d*) To provide practical avenues for the study of the biological and social environment at a suitable level and to provide material and tools for such study.

To begin with, such an approach can best be implemented in those schools where agriculture in some form is already being taught or can easily be introduced, that is, basic schools, post-basic schools in which agriculture is a craft, middle and high schools offering agriculture, and other progressive institutions in the rural areas which are interested in such developments. Of necessity, this will restrict it to certain states and areas, in the beginning. Secondly, the technical leadership will have to come from the universities, more especially, from the agricultural universities and institutes functioning in the area. The work could hence be undertaken in areas immediately surrounding the universities. The cooperation of the state departments of agriculture and of education would both be necessary, and the agricultural extension personnel would come both from the department of agriculture and from the agricultural universities. Each university or major agricultural research institution can assume the responsibility for providing the technical help to at least one such school.

The core of the approach would be the undertaking of projects in agriculture which would be of both economic and educational value, and their use to achieve the aims set out earlier. These projects would be of various kinds and could be operated in some of the following ways:

(*a*) *School projects:* A demonstration of the practical feasibility of viable agriculture in the school has to be made first. Without this, such a programme will not prove acceptable. The project should be of an easy type which can attain success, since a successful demonstration is the first step to widespread adoption. The profit from the completed project should be earmarked for school improvement and should be utilised for some obviously visible improvement. Community support should be sought at every stage.

(*b*) *Individual projects undertaken by the pupils in school:* The profit from such projects should accrue to the students concerned, and the teacher should use it for teaching purposes only. Teachers have to be trained in methods of individual and small-group instruction to enable them to handle such projects in a way which

will be educationally useful to the student. As a variation, the students may form their own cooperative society and work jointly on common projects, sharing out the profits according to the number of shares. This idea may not catch on till the second or third year for obvious reasons — the demonstration of success will have to come first.

(*c*) *Individual projects undertaken by students at home on their own land, with the guidance and support of school teachers as well as extension personnel:* The parents should be involved by being asked to supervise and guide the work of the children. To create further interest, the time spent on this should be recorded and added to school attendance to make up the total requirement of attendance, by a variety of suitable devices which can be worked out, or marks may be allotted for this work. The economic value of the work so done will encourage parents to keep the children at school, get them interested in the school and its work, provide additional teaching personnel, and enable them to see the usefulness of school education.

(*d*) *Group or class projects to be undertaken in school:* These can be arranged on a competitive basis and for cash profit. The best projects should receive, besides whatever they earn, some additional recognition in the academic sphere.

There are various ways in which such projects can be made educationally useful and meaningful. Without attempting to enumerate them a few examples may be suggested.

(*i*) Use for teaching of basic skills such as reading and writing through descriptions of work done, writing up observations and experiments, preparation of instructions, etc and numeracy through the need for various kinds of measurement and computation at each step.

(*ii*) Use for teaching skills of record keeping, observation, comparison, experiments and other aspects of scientific thought.

(*iii*) Use for teaching practical skills involved and relationship of technology to daily work.

(*iv*) Problem-oriented studies in science and social studies beginning with the immediate problems suggested by the projects and expanding into studies of biological and social environment.

(*v*) Making use of the various mass media, sources of information, resource personnel, etc.

Depending on the location, the projects undertaken may include vegetable production, poultry keeping, seed production, etc. The projects should involve skilled work, so that the educational and learning process gets stimulated.

The following kinds of help will be required from agencies outside the school:

(*a*) Technical guidance from extension workers both of the department of agriculture and from universities and research institutes.

(*b*) Necessary inputs from the departments of agriculture such as soil testing kits, pesticides, seed, etc.

(*c*) Suitable teaching aids and study kits from the department of education.

(*d*) Suitable literature and appropriately devised programmes from the mass media, such as radio and film, newspapers, journals, etc.

(*e*) Training of teachers, which is the most crucial need for ensuring the success of the programme.

(*f*) Community support through provision of land, tools, interest and involvement of local authorities, help of parents, and supervision and part-time teaching by farmers and other members of the community.

University education. Making work-experience an integral part of university education would help to generate a greater sense of self-confidence and self-reliance on the part of the student. One approach to achieving this aim may lie in making an in-built provision in each one of our developmental projects for student participation.

Student work should not be regarded merely either as social service or training but must become a distinctive and advantageous part of the project. If this approach is accepted by the project authorities, students can become a source of great strength and dynamism to the project, if they are properly trained and deployed.

What I have in mind is that every university student must be employed in an appropriate plan project for a period of two months every year, while he is in the university. A semester

system of course-curriculum organisation will facilitate the implementation of this idea, although this is not absolutely essential. The summer vacation can be restricted to one month, so that the formal teaching programmes do not suffer. The assignment of students to various projects will need proper planning and adequate consultation between the university and project authorities. Needless to say, the assignment of students will be based on the principle of learning through work and would hence involve a planned matching of the field of study with the field of work. Thus, students of history and archaeology may work for the India Tourism Corporation, of zoology and medicine in the family planning and preventive medicine programmes, of agriculture, botany, chemistry, physics, economics, engineering and home economics in the agricultural development and nutrition programmes and of nearly all fields in pre-primary, primary and secondary education programmes.

All scientific institutions in the country run by Central and State Governments can provide opportunities for students to work in specific projects and can at the same time give a great fillip to the cottage industry movement by supplying detailed manufacturing drawings of new implements, machinery and processes. With these drawings, university students in engineering may be in a position to help village communities in starting small-scale industries, since rural credit is becoming more easily available now.

I am enthusiastic about the educational advantage of such a total involvement of the student community in developmental work, because I have had personal experience of the benefit of such an opportunity. In 1946, there was a serious rice shortage in the then Madras State and at the suggestion of the late Dr. B. Viswanath, who was at that time the Director of Agriculture of Madras State and who incidentally was the first Indian Director of the Indian Agricultural Research Institute, the State Government decided to distribute fertiliser free to the rice farmers of west coast districts like Palghat, Walluvanad and Kasaragod (which are now in Kerala) during the monsoon season. The aim was to increase rice production by a hundred thousand tonnes through the application of nutrients. The operation was technically a gigantic one, since rice farmers in those days were not at all accustomed to using fertiliser. All the students and some of the staff members of the Agricultural College at Coimbatore where I was then studying were offered jobs for two months in this Project and were pressed into service. Well-defined tasks were allotted to each student and there was great enthusiasm and dedication in the implementation of the programme. Unfortunately, there was very heavy rainfall that year and it was later clear to us that much of the fertiliser applied must have gone to the Arabian Sea ! This experience gave an insight into the practical problems of agricultural advance which no book could have ever provided.

We have now 16 agricultural universities, 71 agricultural colleges and 21 veterinary colleges in the country. In all, 43,350 students were enrolled in agricultural subjects and 6,222 students in veterinary subjects during 1970–71. If all these 50,000 students are involved during two months every year in developmental projects such as the pilot projects for dryland farming, multiple cropping, etc, the total annual financial outlay would amount to Rs. 2 crores, on the assumption that each student will be paid Rs. 150 per month to cover the board and lodging expenses and about Rs. 100 for travel. All that is needed is a decision that 10 per cent of the recurring outlay in each agricultural developmental project should be reserved for employing part-time student workers. This amount can be found by suitable readjustments in staffing patterns, since the student-staff will be discharging well-defined duties and carrying out specific items of work.

Generation of self-employment opportunities for agricultural graduates. According to a calculation made by the Man-power Planning Unit of the Union Ministry of Agriculture, we had in 1969 in our country about 51,000 persons with a degree in agriculture. During the period 1969–73, there would be another 19,660 added to this number. In addition, about 7,850 post-graduate students and 1,315 agricultural engineers would also have taken their degrees during this period. The Man-power Planning Unit's estimates reveal that 8,950 agricultural graduates, 4,660 post-graduates and 705 agricultural engineers would become surplus to our requirements on the basis of the likely job availability at the end of the Fourth Plan. It is, thus, clear that if every one looks only for a government job, there is bound to be disappointment. I, therefore, feel that the time has come for agricultural

graduates to take the initiative in making agriculture into a really scientific profession.

A conference of agricultural college students held during 1970 at the Indian Agricultural Research Institute passed a resolution asking the Government of India to set up a system of Registered Farming Practitioners, on the same lines as Registered Medical Practitioners. In the new technology of farming the agricultural graduates can find a powerful ally in winning the respect and confidence of the farming community. With the nationalisation of leading banks, scope exists for credit being made available to the farming practitioners for establishing a small laboratory comprising facilities for soil testing and identification of pests and pathogens. The agricultural graduate who does not own land, should be enabled to get a loan for the purchase of a small area of land, and improved implements. With these facilities, if the farming practitioner uses his knowledge of scientific agriculture, he will be able to render effective service to farmers at nominal fees. For example, he can help through suitable indicator plans to identify micronutrient deficiencies before they become serious. He can help to overcome problems of soil alkalinity and salinity. He can help to ward off nematode problems. He can help to foster an ecology-cum-economics based crop planning. He can also serve as an Adviser to the Banks in the supply of credit. Such a system would not only help to generate considerable self-employment but would also improve the efficiency of farming and the spread of desirable agricultural practices. On the analogy of Medical Councils, Agricultural Councils will have to be established in every State for according registration to the farming practitioners. One primary condition for eligibility for registration must be residence in a village and actual participation in farming operations. By establishing a feed-back relationship with his *alma mater*, the Registered Farming Practitioner can enrich both science and crop production.

Adult education. The dimensions of our educational problem are truly staggering. In spite of all efforts, the number of illiterates in our country increased by 53 million during the period 1961–71, although the growth in literacy expressed as a percentage showed a rise from 24·03 in 1961 to 29·34 in 1971.

With the spread of the new technology and the dramatic transformation of agriculture in certain areas, new dimensions of adult education also appear. There are new needs for education among farming communities. There is a great hunger not only for new knowledge related to agriculture but also for new skills, particularly technical skills connected with it. The demand for "technicracy", a term which I coined recently to signify technical literacy, is likely to be much stronger and deeper and also more widespread than that for formal literacy, or even for functional literacy. New approaches to adult education must capitalise on this new demand and need for "techniracy". Four such approaches suggest themselves:

(*a*) *Agricultural polytechnics as suggested by the Education Commission:* These can be organised for young adult farmers who wish to improve their skills and knowledge. Both short-term and long-term residential courses for such people, who may be expected to be middle or high school graduates, can be organised at Block Headquarters, Extension Training Centres, Gram Sevak Centres, high schools, etc. Janta Colleges would be especially useful for this sort of need-based training.

(*b*) *Short residential course in "techniracy":* These are intended for farmers with no formal educational qualification. The courses would be based on real needs, based on the most frequent requests received from farmers. Skills taught in the short courses would include topics like tubewell construction, choice of pumps, motors and implements, care and maintenance of tractors, construction of low cost water storage and conveyance systems, application of fertilizers and pesticides, reclamation of problem soils, etc.

(*c*) *Functional literacy for rural people, based on their occupational interests and needs:* The literacy course for farmers designed by the Adult Education Department with the technical help of the Extension Division, IARI, and in use as a correspondence course in certain States such as Haryana and Punjab, is an excellent illustration. It is based not only on the interests and needs of farmers, but is so designed that it is closely related to the cycle of agricultural operations, so that an incentive to continue is built into it. Such courses need to be more widely used in all parts of the country. Similar courses need to be prepared for the use of women, related to their needs and interests.

(*d*) *Bypassing the literacy problem:* To the extent that the mass media can succeed in (*i*) transmitting the necessary information and (*ii*) demonstrating frequently the necessary skills for daily living and successful farming,

the question of formal literacy can be bypassed. Radio and films have to be used more intensively and of course television in those areas where it is already or will soon be available. This means that the specifically technical programmes should be still more specific and geared to needs and frequently repeated. It also requires a broader range of programmes not concerned with specific information or skills as such but more closely related to rural life in all its aspects. In the audio-visual world of the future, higher forms of formal literacy may not even be necessary for the vast majority, but only for those interested in pursuing education to higher levels.

Vast possibilities in research. Out of an estimated 18 million farmers with small holdings (1 to 3 hectares), over 4 million are in Uttar Pradesh. The families of such farmers would alone constitute one fifth of our population on the assumption that each family comprises on an average 6 members. We have also a wide range of climate and soil with the result that it is possible to cultivate a variety of economic plants throughout the year. The major task of the agricultural research worker is therefore the development of techniques by which the economic yield per hectare and per gallon of water per day of all the major crop plants can be continuously increased without detriment to the long-term productivity of the soil. I am emphasising long-term productivity, since I am worried about the spread of soil salinity and alkalinity in several parts of the State.

Those who would like to embark upon a research career will find fascinating problems of great relevance to our immediate needs awaiting you in abundance. For example, if one wishes to work on fertiliser, which is a very effective as well as expensive input, you may like to work on problems relating to the use of ammonia directly as fertiliser. In the United States, the direct application of nitrogen fertiliser, both fluid and solid, continues to increase rapidly. Direct application materials account for 44 per cent of the total market and over 48 per cent of total nutrient consumption in that country. Another fruitful area of research relates to synthetic nitrification regulators. The late Dr. S. S. Bains and Dr. K. C. Gulati of IARI found that two lipid associates of *neem* seed (*Azadirachta indica*) and *karanj* seed (*Pongamia glabra*), present up to 10 to 12 per cent in both the seeds, have the property of nitrification regulation. These lipid associates also conserve carbon and thereby soil organic matter for the same reason that they act as nitrification inhibitors, i e, by keeping the growth of soil microflora under check and thereby introducing "family planning" among micro-organisms. Nitrification regulators not only help to reduce losses of nitrogen due to leaching and denitrification in crops like rice, but also help to minimise the hazard of nitrate accumulation in food and surface water. In the USA, it has been observed that potasium azide, when added to anhydrous ammonia, helps to insure against possible nitrate pollution of ground water. We need such research in our country urgently, since our people do not easily get a good supply of drinking water at many places.

In the field of water management too one can find an exciting research career. A system of irrigation which we should develop speedily is the drip or trickle irrigation method, so successfully used in countries like Israel and USA under semi-arid and arid conditions. The method has also great value under conditions of high water and soil salinity. The method provides us with the possibility of raising the permissible salinity level of irrigation water. In the field of pesticide research, the development of a viral pesticide against insect pests of the genus *Heliothis* in the USA has paved the way for research on a wide range of microbial pesticides.

If one wishes to work in the field of genetics and plant breeding, one can render great service by developing usable forms of male sterility in cotton, apomixis in *sorghum* and physiologically more efficient ideotypes of oilseed and pulse crops. There are also problems in breeding varieties specifically for industrial uses which need attention. For example, the man-made fibre industry in our country claims that the production of man-made fibres in the next three decades would be growing at an average rate of 44 per cent every five years and that by the year 2000, man-made fibres would constitute 50 per cent of the total apparel fibres used. There are now opportunities for breeding cotton strains which respond to specific chemical finishing treatments, so as to invest the cotton fibre with easy-care properties. The development of such strains and of hybrid cotton using male sterility would make important contributions to the economy of our semi-arid areas. Similar opportunities for innovative research in the fields of microbiology, agricultural engineering, grain storage and all disciplines related to agriculture are immense.

THE INDOMITABLE BLOOD-SUCKERS

H. G. SEN

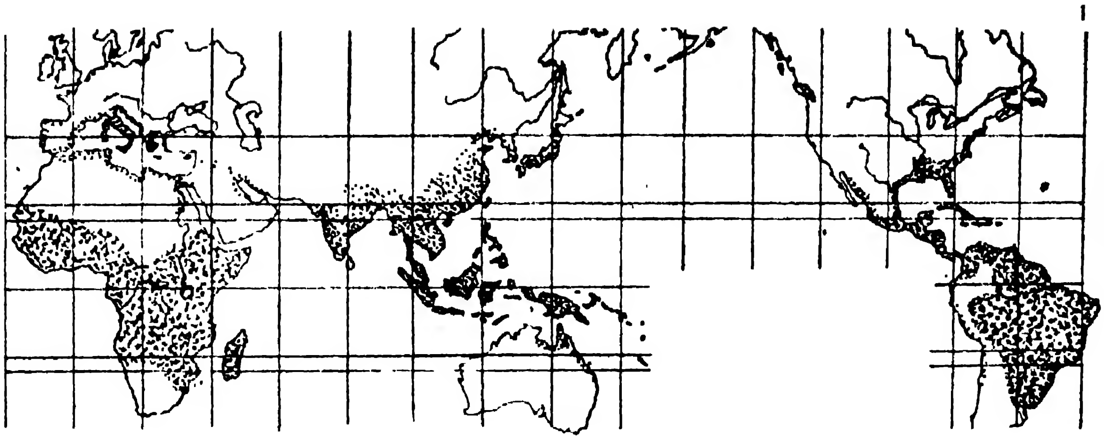
They sneak in through the skin of unwary barefoot walkers, nest, feed and reproduce in the small intestine, and make a wreck of the man. A Bombay team of parasitologists has at last succeeded in raising the human hookworm parasite in animal hosts. The way is now open for the evaluation of a curative drug. Will this be the country's proudest breakthrough to contain a widespread scourge?

THERE are 3,200 million people living on earth today. Imagine, of these, 700 millions carry in their body a parasite that can drain out vitality like no other worm infection known to man. Till very recently, malaria and hookworm disease used to be mankind's two most dreaded afflictions. Malaria is now on its waning march. But not hookworm disease. In an intensive study in 1947 Stoll had put the estimate of the world infected at one-fifth of the total; the figure has shot up much higher today. And this despite the fact that no other human worm infection has attracted so much medical attention and investigation as hookworm.

Seven hundred million infected ! But not all necessarily diseased. Clinical illness may be manifested where the host harbours more than 50 of the parasites, particularly so if he lives on a sub-standard diet. In a country like India, that is quite often. Here the infection rate is as high as 80 to 90 per cent, especially in plantations and mines. In underdeveloped countries, the blood-sucker has a gay time indeed. Malnutrition and unspeakable hygiene compound the scourge.

Biologically there are two known species of hookworms: *Necator americanus* and *Ancylostoma duodenale*. The former was considered to be the parasite of the New World because of its first isolation in the USA in 1902. It was then referred to in common parlance as "the American murderer". The Old World parasite, *Ancylostoma*, is of European origin. *Necator* which is slightly smaller than *Ancylostoma* is the dominant species and 90 per cent of all hookworms reported from the tropics are of this type. Very likely this species was introduced to America by slaves from Africa. It is believed that hookworms have been associated with man as a host for at least three thousand generations: that takes us way back to early cultures.

Adult hookworms are relatively stout, somewhat cylindroid in shape and are provided with teeth or cutting plates inside the mouth cavity. The colour is greyish yellow though at times they look quite red because of the blood they suck from the small intestine. Each worm sucks approximately 0·1 ml to 0·2 ml blood per day. Sexes are separate and the males measure 7 to 11 mm and are smaller than the females which reach up to 9 to 13 mm in length. The eggs of both the species when expelled with



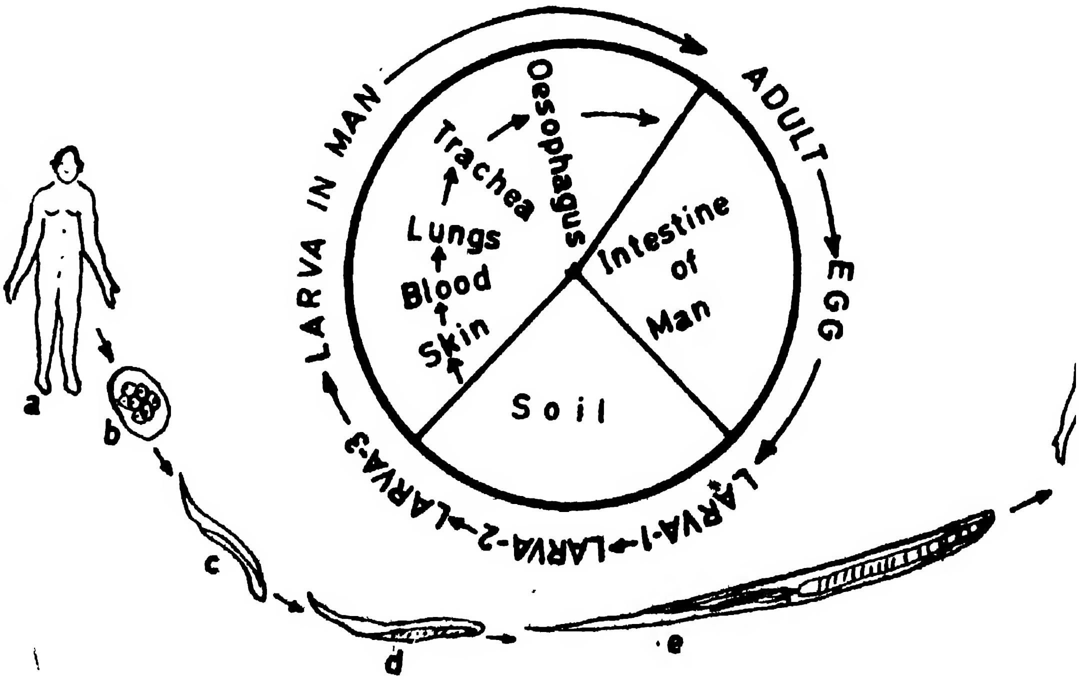
World map showing the hookworm-infected areas

the excreta look identical except that the eggs of *Necator* are somewhat longer and narrower. The females have a daily egg output of approximately 10,000 to 20,000.

Eggs are discharged in the stool which when deposited in a moist, shady (sunlight has an adverse effect on them) warm place with decaying vegetation, hatch in 24 to 36 hours and the emerging larvae (embryo) begin to feed on bacteria and organic debris. After about three days of feeding and growth, the larva sheds its cuticle (skin) and now as a second stage grows to a length of 0·5 to 0·6 mm. In the next 5 to 7 days, the larva again sheds the cuticle which it retains as a protective covering and develops into the non-feeding third stage. This is the infection stage. The unwary barefoot passers-by, while walking on or handling the contaminated soil, become infected. The infective larvae which enter through the feet or the hands and penetrate down to the deeper portion of the tissue beneath the skin, now invade the blood stream and are carried to the lungs through the heart. After a few days' stay in the lungs, they are carried up the respiratory passage, come into the mouth cavity on their journey to the small intestine where they shed the cuticle (third moult) and attach themselves to the villi. They grow in size, become sexually differentiated and then develop into adults following the last moult. The females first begin to lay eggs within a period of 6 weeks. Though the usual process of infection is through the skin, man may also become infected by swallowing unwashed fruits or vegetables contaminated with these larvae.

Man is the only normal definite host, although

Life cycle of hookworm parasite:
a: man with adult worm in intestine
b: egg passed in faeces
c: larva-1
d: larva-2
e: larva-3
f: man infected through skin



rarely wild animals have been reported to carry a natural infection of hookworm parasites. After the parasites settle in the small intestine, their main business is the production of eggs and they tend strictly to business. In this way, they are different from microbes which multiply enormously inside the host, while hookworms like other nematode parasites grow into adults without proliferation, i e one larva — one adult. The propagation of the infection, however, depends on 1) adequate source of infection in a community; 2) indiscriminate defecation in favourable places so that eggs of hookworms after being deposited with the excreta develop into infective larvae; and 3) the opportunity of infective larvae to come in contact with human skin to complete their life cycle. In many tropical and subtropical countries, conditions are quite favourable to maintain the infective population of larvae throughout the greater part of the year.

which are sucked into their mouth. Ulceration develops at each site of attachment (which is changed from time to time) and blood escapes from the damaged vessels of the villi into the immediate vicinity of the attached worms.

The most noticeable symptoms of hookworm disease are the progressive iron deficient anaemia (hypochromic microcytic) associated with gastric and intestinal dyspepsia, a condition known since 3500 years ago. During the last 60 years, the mechanism by which hookworms induce disease in man had been the centre of considerable controversy: the spectrum of opinions varied between intestinal haemorrhage, intravascular haemolysis, depressed erythropoiesis, malabsorption, intoxications from warm metabolic products and from secondary microbial invasion of the wall of the alimentary canal. It was only in the last decade that evidence has been obtained to show that only the intestinal haemorrhage induces hookworm anaemia. Among other recognised symptoms are pallor and disinclination to play or work (popularly interpreted as laziness), breathlessness after slight exertion, " pot-bellied " abdomen and oedema. Further, children may suffer several years' retardation in physical and mental development with puberty long delayed.

PARASITES IN MAN

PROTOZOA (unicellular), e g malaria, amoeba, etc	HELMINTHS (worms, multicellular), e g filaria, hookworms, guinea worms, tapeworms, etc	ARTHROPODS (jointed legs), e g mosquitoes, bed bugs, flies, etc

Diagnosis

Diagnosis of the infection is of course, quite easy — the eggs are easily identifiable under the microscope. Community diagnosis, i e the relative degree of severity of the disease in a community, can be indicated by ascertaining quantitatively the mean egg count per gram of faecal sample. It is known that malnutrition is frequently associated with hookworm infection either as an underlying condition or due to hookworms themselves. Hence it is important to carry out studies on the nutritional deficiencies of the hookworm infected population in order to determine the causes.

When the infective larvae enter the skin, they may cause " ground itch " characterised by itching and inflammation. During migration through the lungs they produce microscopic damage in the air sacs. After reaching the small intestine, worms attach themselves to the intestinal mucosa and begin to digest the villi

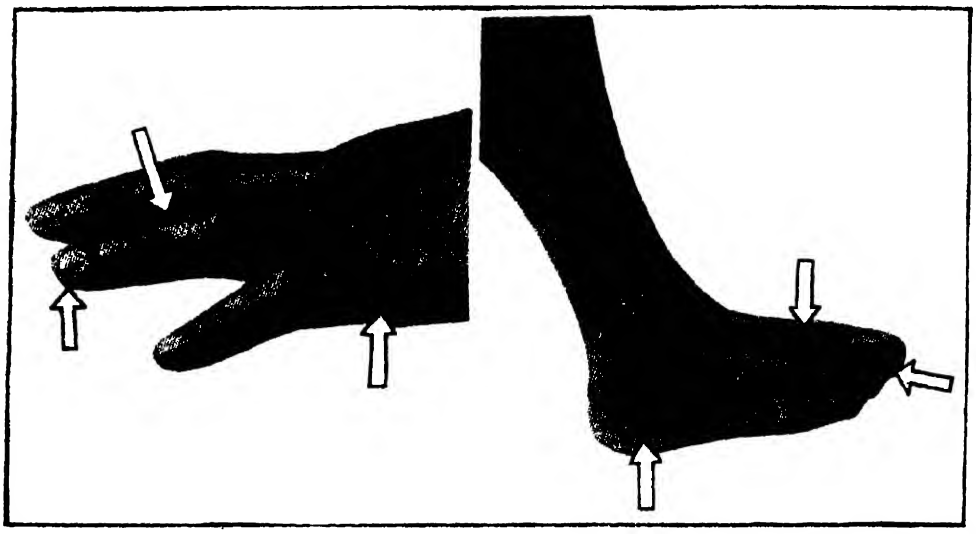
Some non-human species of hookworms, particularly *A. braziliense* and *A. caninum* may penetrate through the skin in a human host, but fail to find their way to the blood vessels for their journey to the lungs. They then wander aimlessly just under the skin surface, sometimes for 3 months or more, causing tortuous channels — a condition known as " creeping eruption ".

It is not yet clear whether the hookworm disease can confer immunity on man. There is no direct evidence. As a mammal he, however, may have the biological potential of protection that other mammalian species, e g dogs and

cats, exhibit against their own hookworm parasites. It has been reported that a hookworm parasite may persist in human host for a period of 6 to 15 years in the absence of reinfection. The role of nutrition is of course vital in building up an active immunological process as evidenced by animal studies. In many areas of the world, man is constantly exposed and re-exposed to severe infections from his heavily contaminated environment; yet man survives.

thriving bed. For several decades, the search has been going on all over the world, but not a single laboratory animal was found suitable.

The information in the published literature suggested that dogs and cats may be experimentally infected with *A. duodenale* or *N. americanus*, but the number of adult parasites establishing in these animals is very negligible and these being larger animals are unsatisfactory for experimental investigations.



Left: Vulnerable points through which the hookworm finds its way into the human system. Below, left: Creeping eruption caused by dog hookworms, *A. braziliense*. Below, right: Hookworm disease in a boy showing stunted growth and distended abdomen

How does he do it ? An honest answer is — we do not know, despite years of investigation.

Decades of concentrated research has gone into the problem of hookworm disease in several laboratories of the world, but the ideal drug is yet to come. Amongst drugs available for treatment in hookworm infection, Tetrachlorethylene, Alcopar, Thiabendazole and the more recently introduced Decaris, which though claim to have success in expelling parasites from the small intestine, are far from satisfactory in view of their poor efficacy and undesirable side-effects. The reason why the ideal drug remains elusive is the lack of an experimental model, i e the lack of a suitable laboratory host which could be profitably and conveniently utilised for experimental chemotherapy. For many years it was the practice to extrapolate freely from the findings in hookworm disease of other animals to the related disease in man. Though this has occasionally been useful, it has also led to the acceptance of erroneous theories as fact.

Researchers knew for any breakthrough, they would have to find an animal host that would allow the human parasite an easy

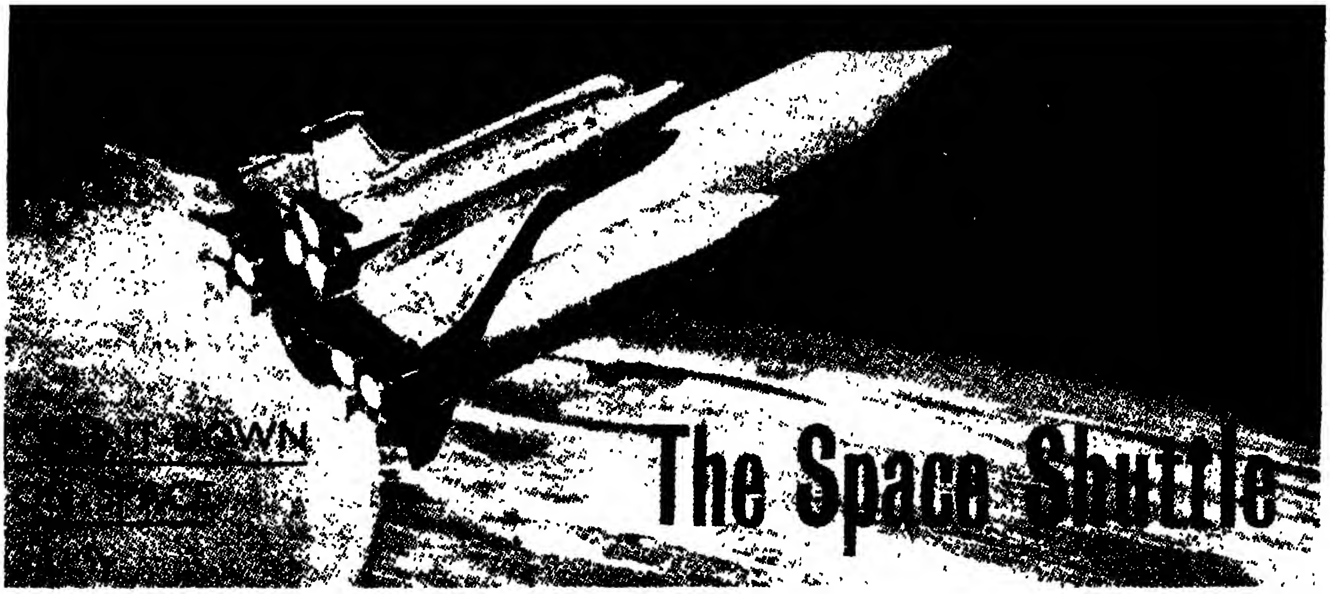
Hookworms on the intestinal wall. Each one of them sucks 0·1 ml to 0 2 ml of blood a day

Breakthrough comes

The breakthrough came from one of our own laboratories in 1967. The author for the first time reported the complete development of human hookworm *N. americanus* in golden hamsters. Golden hamsters had been tried by laboratories elsewhere but failed to yield any result. The author's success came when he chose hamsters of a much younger age. These animals when infected at birth provide favourable media to these parasites which survive to maturity (in contrast to older hamsters which expel the entire parasite load while they are at a juvenile stage). Even though these parasites developed to maturity in hamsters infected at birth, serial passage (transfer from hamster to hamster) of the hookworm larvae into hamsters was extremely difficult if not impossible because of low yield of infective (3rd stage) larvae from faecal cultures. This problem, however, was solved by administration of corticosteroid. The administration of corticosteroid to hamsters during the first five passages induced hookworms to adapt to this abnormal host. Hereafter, this adapted population has been maintained by serial passage without cortisones in hamsters for a period of 4 years now. The population of parasites not only survive in hamsters, but are also established and maintained independently. They reach normal size comparable to that in man, mature, mate and produce viable eggs. It is reasonable to believe that this host provides a favourable medium and satisfies the life requirements of this adapted population. This new host-parasite system serves as an excellent tool in the study of experimental human hookworm infections, since a relatively high percentage of infective larvae reach sexual maturity and establish as a stable population which is compatible to hamsters. Now drugs can be tried out on these infected animals. Maybe, soon enough there will be a drug, safe and effective, to cure the hookworm disease in a single dose by expelling the total parasite population!

The other most important factor in hookworm control is the education of the people in the use of sanitary depositories for faeces. Installation of community sewage disposal systems in cities and towns may eliminate the problem to some extent. In rural areas sanitary pit privies may take the place of flush toilets. Alternatively, bored-hole latrines with a concrete top are better adapted for use. The greatest need is to link hookworm control to the more comprehensive programme of environmental sanitation and improved health based on preventive care and nutritional betterment of the poorer classes. For speedy eradication of the parasite it is advisable to undertake mass treatment simultaneously with control measures.

" It's amazingly human. . . "



The Space Shuttle

THE concept of a space shuttle is not so new after all. There are only a few more moon-shots to go. After that it will perhaps take decades to launch a manned probe towards Mars. Now the focus is on the orbiting space laboratory. This is where space shuttles come in. Today every hardware that goes out into space has a once-only use. Maybe the enormous expense can be justified when it comes to reaching out for Mars or Jupiter. But near-Earth manned space projects like the skylab are designed to last for a longer time range. Which means, the orbiting space station will need repeated supplies — in fact something like a space shuttle — a space transportation system that will not be thrown away after a single use. The plans are already on the drawing-boards at NASA and will be developed over the next six years at a total cost of approximately $5·5 billion.

It will be a manned reusable space vehicle which will carry out various space missions in Earth orbit. The shuttle, which looks like an airplane, will have rocket engines instead of jet engines. It will be launched vertically, fly into orbit under its own power, stay there as long as needed and then glide back into the atmosphere and land on a runway—in short, the world's first reusable spacecraft.

The spacecraft will consist of two stages. The first stage booster will be an unmanned liquid- or solid-fuelled rocket. The second stage orbiter will look like a delta-winged airplane and will be piloted by two men who will fly it back to Earth for an airplane-like landing.

The orbiter with its payload and crew will continue in Earth orbit for missions lasting about seven days, or possibly as long as 30 days. The manned space shuttle orbiter will deploy in Earth orbit all types of scientific and applications satellites weighing up to 29,500 kilograms and thereby replace most of the expendable launch vehicles currently used.

The initial engineering, design and cost analysis studies of a space shuttle included concepts of both a fully reusable manned booster and orbiter, and an unmanned booster and manned orbiter. However, in June 1971, it was decided to go in for extensive studies on the latter system. This configuration, it was concluded, could be developed for about half the cost of a fully reusable manned system and yet have equal operational capability in space.

Space shuttle configuration

Booster: Two different kinds of boosters are being studied now : a liquid-fuelled recoverable and reusable rocket, and expendable solid-fuelled rockets. The liquid-fuelled booster would be powered by new pressure-fed engines; it would launch the manned orbiter to an altitude of about 55 to 65 kilometres, jettison, descend into the ocean by parachutes, be recovered and reused. The engine's propellants, kerosene or propane and liquid oxygen, would be fed into the combustion chamber by 150 kg of pressure in the tanks. Six engines of about 500,000 kg thrust each would be used.

The solid-fuelled booster could be twin solid-fuelled rockets, clusters of three metres or 3·9 metres, which would burn in parallel with the orbiter. Both booster and orbiter engines would

ignite and burn simultaneously at launch, the booster would jettison at an altitude of about 55 kilometres while the orbiter engines continue burning to carry it into space.

Orbiter : The manned orbiter will be powered by three high pressure engines with 230,000 kg thrust each in space.

The orbiter will be approximately 36 metres long and have a wing spread of 23 metres. The cargo compartment, or payload bay, will be approximately 4·5 metres in diameter and 14 to 18 metres long. Payload capability will be up to 29,500 kilograms.

The crew will consist of two pilots and two flight engineers. A special pressurised sortie module can be carried in the payload bay to accommodate up to 12 persons, or passengers who are not astronauts. Scientists and engineers will have an opportunity to accompany their experiments into space for the first time. Unlike previous manned spacecraft, the shuttle orbiter will have reusable external insulation. Each vehicle will be capable of carrying out 100 space missions.

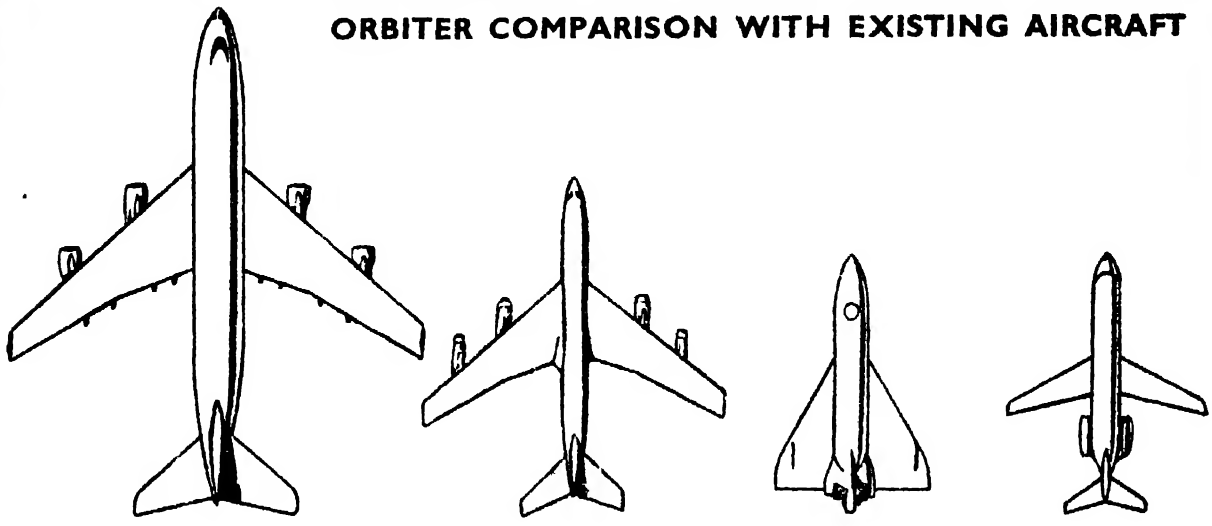
Space shuttle missions

The space shuttle will be used to carry into space virtually all of the nation's civilian and military payloads, manned and unmanned. It will also accommodate the future need of commercial users and foreign governments. Those will include all the automated scientific space probes and earth-orbiting solar and astronomical observatories. Applications of payloads will be earth resources sensing, communications, meteorological and geodetic satellites.

Normal manned missions will be up to seven days' duration in which scientists and engineers will conduct investigations in space aboard a pressurised module in the payload compartment. Astromechanics may also repair satellites in space, retrieve them and return them to Earth if necessary.

A smaller powered vehicle, called a space tug, can be deployed from the shuttle for manned or unmanned space operations such as boosting a communication satellite to higher altitudes including synchronous orbit and retrieving payloads from high orbits. ■ ■

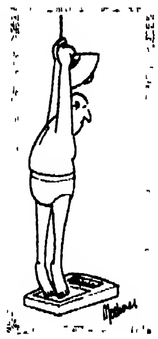
ORBITER COMPARISON WITH EXISTING AIRCRAFT



	747	707	Shuttle orbiter	DC-9
Wingspan ..	59·6 M	43·4 M	22·8 M	28·7 M
Length ..	70·5 M	46·6 M	36·6 M	36·4 M
Oper. wt. (empty)	165,920 kg	61,236 kg	63,400 kg	26,000 kg
Landing speed ..	256 km/hr	256 km/hr	296 km/hr	208 km/hr

The Medical World

FAT IS FATAL



"LET me have men about me that are fat," said Julius Caesar. The Roman emperor's preference was based on the assumption that fat people sleep of nights and are less inclined to bump off men who have become gods.

Current medical opinion, however, is not inclined to favour the corpulent. The extra calories they consume go to the fat depots of the body and may shorten their life by years. With growing affluence, overeating which is now largely a pastime of the idle rich, is bound to become the most prevalent form of malnutrition. So, next time you munch a handful of *chana* or nibble a chocolate bar to appease that mid-morning hunger, ask yourself: "is it really necessary?"

Obesity research is one of the newest areas to engage the interest of scientists working on the control of human ageing. Forty years ago it was shown that the life span of mice and rats could be increased 20 to 40 per cent by food restriction consisting either of alternate full-feeding and fasting one day out of three, or by overall calorie limitation to 60 per cent of the diet of the "control" animals. It was found that longevity was the effect of suppressing all causes of death such as tumours. Dr. Alex Comfort, the leading gerontologist, is hopeful that such results can be extended to human beings, particularly because recent advances in gerontology have made it possible to measure short-term ageing. And if natural decay can be slowed down, by restricting food intake to the same extent as in the rodent experiments, we should be having life spans of 90 to 100 years.

This is the kind of thing that would have warmed the heart of Ripley ("Believe It or Not"). Picture on right shows a Scotsman who weighed 214 kg and that on left the same man after he lost 133 kg by a medically supervised diet of tea, coffee, water and vitamin pills. He had brought on his enormous weight by overeating

Disease of affluence

There lies the rub — if we are able to cut down our consumption of sugar and starch. It is all too easy to overeat. Habits of overeating are inculcated in childhood by indulgent parents and relatives, and carried over to adulthood. It is essentially a disease of civilization and is particularly prevalent in the rich and the relatively poor. People sometimes visit fashionable restaurants more to be seen there than to eat there, but the eating habits thus developed are carried forward to the years of life when sitting in fashionable restaurants is no longer necessary.

According to their eating patterns, obese persons can be divided into the gluttons (those who prefer to get their calories in kingsize doses) and the "nibblers" who have a nibble every half an hour.

Imbalance

According to Dr. John Anderson, writing in the *British Medical Journal*, obesity is seldom the direct result of endocrine disease. It is more often than not due to an imbalance between intake and output over a period of time; the calories not immediately consumed are converted into triglyceride fat and deposited in the adipose tissue depots of the body. In childhood obesity the imbalance is mainly due to overeating, while in adult life it is mainly due to a reduction in physical activity. And the more obese you become, the less active you grow. Even a little extra helping at the dinner table, if kept up for sufficiently long, can lead to an imbalance, eg two thin slices of bread, 19 g of milk and one large apple make for a 3 per cent error in the calorie balance of an active man, and can lead to a weight gain of 4·5 kg in a year.

How does one judge whether there is obesity? Doctors generally go by standard tables

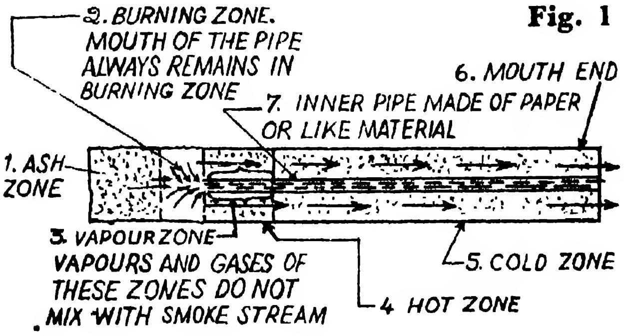
(Continued on page 42)

For Fag-fiends

CIGARETTE smoking has earned a bad name by now on account of its association with lung cancer, but there seems to be no way to stop addicts of the "cancer stick". To help them keep puffing, comes a new type of cigarette filter which is claimed to prevent the harmful constituents of cigarette smoke from entering the mouth and lungs. The designer is Mr. Arjan Singh Gill of Chandigarh, a Sikh who has not had anything to do with tobacco.

The novel cigarette design patented by Mr. Gill promises to eliminate from the smoke most of the harmful ingredients known to cause

Fig. 1



cancer, bronchitis and allied diseases. The conventional filter has failed to do this effectively; while other methods based on chemical additives have not proved successful due to the alien tastes they introduce in the smoke. The new design simply involves the insertion of a thin paper tube inside a conventional cigarette.

Mr. Gill's idea is based on the well-known process of combustion: when solid combustible matter is heated, it is first transformed into the liquid and then into the gas before it actually burns. The combustible constituents escape as smoke, the incombustible matter is left as ash. This process is demonstrated to school students by means of a candle flame. The flame is known to consist of four main zones: liquid zone, inner black zone, luminous zone, and the non-luminous outer mantle. When one end of a short metallic tube is introduced in the inner black zone and its other end lighted, one gets a brilliant flame, indicating formation of combustible gases in this zone. The flame is

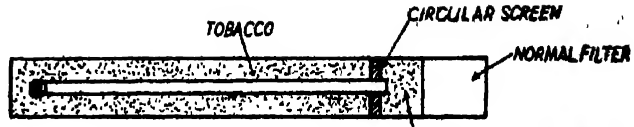


Fig. 2

bluish when the tube is introduced in the luminous zone, indicating presence of combustible vapours; there is no flame when it is introduced in the luminous zone, indicating absence of combustible gases or vapours.

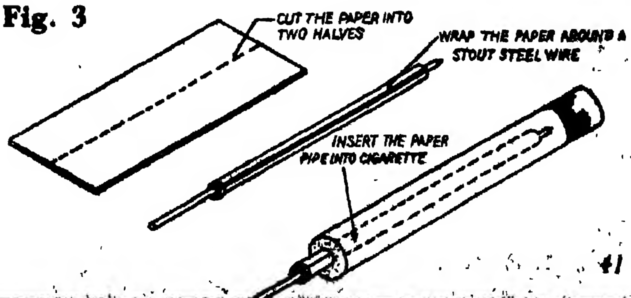
A lighted cigarette can likewise be divided into five main zones: ash zone, burning zone, vapour zone, hot zone, and cold zone (Fig. 1). As it is sucked, the smoke from the burning zone carries along the unburnt gases and vapours, present in the vapour and hot zones, into the mouth. Most of the harmful ingredients — carbon monoxide, hydrocarbons, amines, hydrogen cyanide and sulphide, etc are concentrated in the unburnt portion of the smoke. Mr. Gill's cigarette is designed to prevent the mixing of these products of incomplete combustion with the pure smoke coming from the burning zone.

When the modified cigarette (Fig. 2) is lighted and puffed, one end of the inner paper tube always remains in the burning zone, such that the pure smoke is directly conveyed to the smoker's mouth through the tube, bypassing the vapour and hot zones. Since gases take the path of least resistance, the major portion of the inhaled smoke flows through the tube and only a negligible amount, if any, through the main body of the cigarette. Moreover, due to easy passage of smoke there is better supply of air, hence better combustion.

Trials with existing brands of cigarettes have shown that after modification their smoke is softer and less pungent, does not irritate nose, throat or lungs, and there is no smokers' cough. Yet, there is complete satisfaction to the smoker, because most of the nicotine is produced in the hot zone and therefore is not eliminated.

You too can try the redesigned cigarette (Fig. 3). Take a leaf of paper used for making self-rolled cigarettes from loose tobacco, cut into

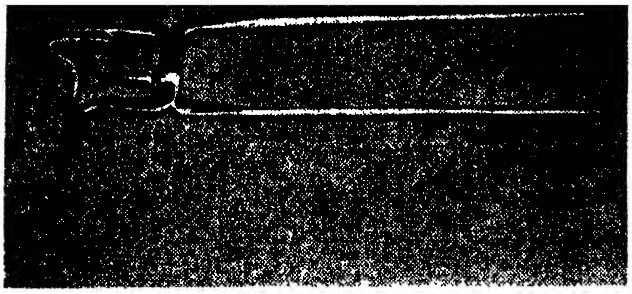
Fig. 3



two halves lengthwise, wrap one piece around a bicycle wheel spoke or similar wire, insert the whole axially two inches inside a cigarette of your liking, and extract the spoke carefully out, leaving the paper tube inside. Now, clip off the protruding portion of the tube, crush to close its mouth by means of the spoke, light and smoke from the other end. It should be noted that the tube should not pass through the entire length of the cigarette; it should stop at least half an inch from the mouth end to prevent hot draught being sucked in.

Two-in-one Tongs

THESE simple-looking tongs should be a boon to housewives. They combine the functional qualities of a *chimta* and a *sansi* commonly used in Indian homes for handling utensils and cooking vessels. The inventor, Mr. S. G. Borlikar of Bombay, has named it 'Sevak'.



This dual-purpose implement comprises a pair of suitably designed tongs with long handles and hinged at a point; another tong, without handle, is also rivetted at the intersection of the first two tongs. The implement is so designed that its jaws can simultaneously hold a vessel in position by gripping its wall vertically and also lift up and hold its lid horizontally. This capability makes it a useful tool in laboratories, hospitals, workshops, etc — wherever there is a need to avoid a sudden gush of steam, harmful vapours, chemicals and powders from a container.

Badiuddin Khan

The Medical World

(Contd. from page 40)

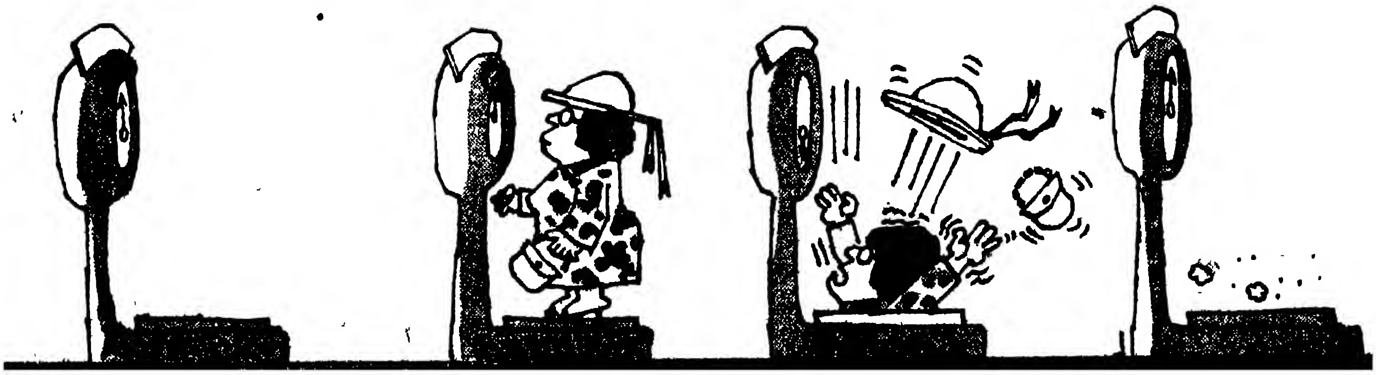
of "ideal" weight and judge that there is obesity when the weight exceeds the ideal weight by 10 per cent or more. But the total body weight may not give a good indication of the fat mass. However, a more accurate measure of body fat is the skin fold thickness, judged by spring-loaded calipers which exert a constant pressure at all ranges of thickness. When body fat exceeds 20 per cent of the total body weight in adult men and 30 per cent in women, we may say there is obesity.

Treatment

In obesity, the patient must mostly minister to himself, though of course, medical advice is always valuable, particularly in ruling out pathological causes. There should be motivation, a will to count calories and to lose weight. Weighing once a week is better, psychologically, than weighing every day. If a negative balance of 200 kcal per day is established, this will result in a weight reduction of about 9 kg in a year. The diet should be well-balanced, varied and low in total calories (1000-1500 daily). "Slimming" foods should be avoided because there is a temptation to consume them in addition to the regular diet.

Appetite suppressants like fenfluramine and diethylpropion have given good results in clinical trials, but in routine use there is a risk that they may be habit-forming. Motivation regarding diet is greatest at the start of the treatment and therefore appetite suppressants should not be given *ab initio*, but at a later stage, when the patient has shown that he can lose weight.

Like the findings on cigarettes and lung cancer, obesity research is going to prove difficult in application. What, you might ask, is the use of living 40 years longer if all the things that make life bearable are put on the prohibited list?



IS MAN INHUMAN BY NATURE?

LEON EISENBERG

Theories that human behaviour is based on instincts violate the findings of biopsychology. Man is essentially his own product

WITH each decade, scientific findings translated into technology radically reshape the way we live. Technical capacity has been the ruling imperative, with no reckoning of cost, either ecological or personal. If it could be done, it has been done. Foresight has lagged far behind craftsmanship. At long last we are beginning to ask, not *can* it be done, but *should* it be done ? The power of our technology so foreshortens the time between its application and the possibility of its correction that we must learn to think through before we act out.

If we were to understand each other even half as well as we comprehend the energy of the stars, we might yet spare ourselves the horrors we face from traducing those energies into weapons that endanger all life. If psychiatry cannot yet provide a firm basis for that understanding, it may nonetheless be of service if it dispels the myths and the pseudoknowledge that obscure the search for truth.

In the title of this article underlies its conclusion: that there is to human nature a nature that is other than naked ape, actuated by territorial imperatives and impelled by aggressive instincts. Such a conclusion must seem outrageously

optimistic in an era in which Americans "waste" Vietnamese, in which West Pakistanis massacre their countrymen in the East — but there is no need to retell the litany of violence. How, in the teeth of this "evidence," can we disbelieve Morris, Ardrey, or Lorenz? [Desmond Morris: *The Naked Ape.* R. Ardrey: (1) *African Genesis,* (2) *The Territorial Imperative;* Konrad Lorenz: *On Aggression.*] How can we challenge Freud, his illusions of civilisation shattered by the barbarities of World War I when he wrote: "The very emphasis of the Commandment: Thou shalt not kill, makes it certain that we are descended from an endlessly long chain of generations of murderers whose love of murder was in their blood as it is perhaps also in our own . . ." (*Reflections on War and Death*)? Or again: "The tendency to aggression is an innate, independent, instinctual disposition in man . . ." (*Civilisation and Its Discontents*). How, indeed?

This is no mere academic exercise, of concern only to students of behaviour. The planets will move as they always have, whether we adopt a geocentric or a heliocentric view of the heavens. It is only the equations we generate to account for those motions that will be more or less complex; the motions of the planets are sublimely indifferent to our earthbound astronomy. But the behaviour of men is not independent of the theories of human behaviour that men adopt. One example may serve to explicate this thesis.

So long as the "nature" of insanity was thought to be violent, and so long as the insane were chained, beaten and locked in cells, madmen raged and fumed. With the introduction of the "moral treatment" of the insane at the beginning of the 19th century, violence in mental asylums markedly abated.

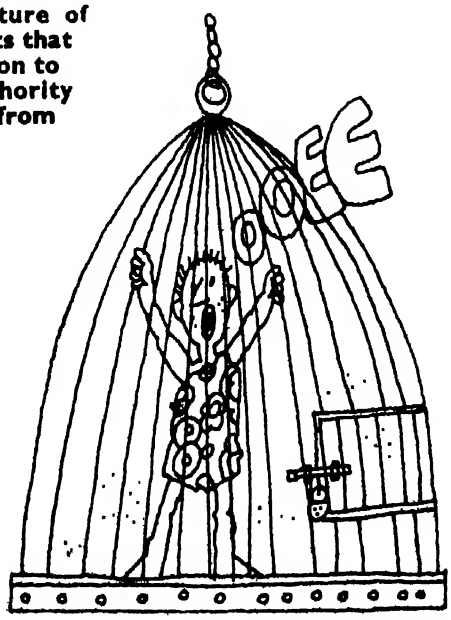
A century later, the "nature" of insanity was perceived as social incompetence; the sick were "protected" from stress, and the institution assumed responsibility for all decision-making. Misguided benevolence stripped the patient of adult status and generated automation-like compliance; the result was the chronicity of the back wards of our state hospitals. A generation ago, the concept of the therapeutic environment, with its rediscovery of self-government and personal responsibility as the bases for attaining competence, began to reverse the cycle of self-perpetuating hospitalisation. This led to a decline in what had been a steadily rising population in US mental hospitals, a decline that began before the era of psychotropic drugs.

Do not mistake me. Psychosis is no mere social convention; it has a psychobiological existence independent of systems of belief. But its manifestations and its course are profoundly influenced by the social field in which the patient and his caretakers operate. Belief systems act no less profoundly on the remainder of mankind. The doctor's very presence relieves pain. Teachers' expectations govern pupils' performance. The citizens' confidence in the benevolence of the social order maintains its stability.

What we believe of man affects the behaviour of men, for it determines what each expects of the other. Theories of education, of political science, of economics, and the very policies of governments are based on implicit concepts of the nature of man. Is he educable? Is he actuated only by self-interest? Is he a creature of such dark lusts that only submission to sovereign authority can save him from himself?

What we choose to believe about the nature of man has social consequences. Those consequences should be weighed in assessing the belief we choose to hold, even provisionally, given the lack of compelling proof for any of the currently fashionable theories. In insisting on an assessment of potential outputs in addition to a critique of inputs, I do not suggest that we ignore scientific evidence when it does not suit our fond wishes. Any hope of building a better world must begin with a tough-minded appraisal of the facts that are to be had. The thrust of my argument is that there is no solid

Is man a creature of such dark lusts that only submission to sovereign authority can save him from himself?



foundation to the theoretical extrapolation of the instinctivists, the ethologists, the behaviourists, or the psychoanalysts, despite the special pleading that often is so seductive to those eager for a " real science " of behaviour.

Further to the point, belief helps shape actuality because of the self-fulfilling character of social prophecy. To believe that man's aggressiveness or territoriality is in the nature of the beast is to mistake some men for all men, contemporary society for all possible societies, and, by a remarkable transformation, to justify what is as what needs must be; social repression becomes a response to, rather than a cause of, human violence.

Pessimism about man serves to maintain the status quo. It is a luxury for the affluent, a sop to the guilt of the politically inactive, a comfort to those who continue to enjoy the amenities of previlege. Pessimism is too costly for the disenfranchised; they give way to it at the price of their salvation. No less clearly, the false " optimism " of the unsubstantiated claims made for behavioural engineering, claims that ignore biological variation and individual creativity, foreclose man's humanity.

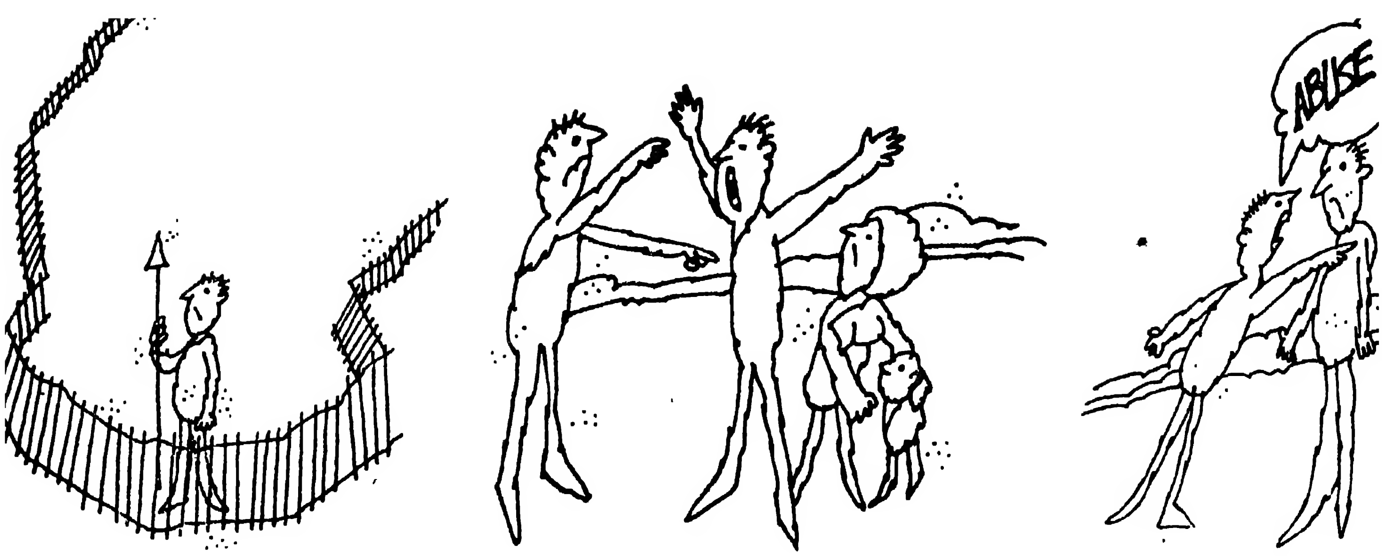
What is known about the power of the social-psychological determinants of human behaviour compels the conclusion that the set of axioms for a theory of human nature must include a Kantian categorical imperative: *men and women must believe that mankind can become fully human in order for our species to attain its humanity.* Restated, a soberly optimistic view of man's potential (based on recognition of mankind's attainments, but tempered by knowledge of its frailties) is a precondition for social action to make actual that which is possible.

Innate schemata and racial purity

Some readers may object to " politicising " what should be a " scientific " discussion. My contention is that it is necessary to make overt what is latent in treatises on the " innate " nature of man. Consider, for example, Lorenz. Surely, those who have been charmed by his film of himself leading, like a mother goose, a brood of greylag geese about the farmyard will recoil from identifying his works as political. What is political about inborn schemata, innate releasing mechanisms, species-specific mating patterns, and the like? A great deal, as his own writings make clear, when such concepts, of dubious applicability to animal behaviour itself, are transposed directly to man without attending to species differences and to phyletic levels. Lorenz found it possible to write, in 1940, that the effects of civilisation on human beings parallel those of domestication in animals. In domesticated animals, he argued, degenerative mutations result in the loss of species-specific releaser mechanisms responding to innate schemata that govern mating patterns and that serve in nature to maintain the purity of the stock. Similar phenomena are said to be an inevitable by-product of civilisation unless the state is vigilant:

> The only resistance which mankind of healthy stock can offer ... against being penetrated by symptoms of degeneracy is based on the existence of certain innate schemata .... Our species-specific sensitivity to the beauty and ugliness of members of our species is intimately connected with the symptoms of degeneration, caused by domestication, which threaten our race. .... Usually, a man of high value is disgusted with special intensity by slight symptoms of degeneracy in men of the other race ...... in certain instances, however, we find not only a lack of this selectivity ... but even a reversal to being attracted by symptoms of degeneracy .... Decadent art provides many examples of such a change of signs ..... The immensely high reproduction rate in the moral imbecile has long been established ..... This phenomenon leads everywhere ... to the fact that socially inferior human material is enabled ... to penetrate and finally to annihilate the healthy nation. The selection for toughness, heroism, social utility .... must be accomplished by some human institution if mankind, in default of selective factors, is not to be ruined by domestication-induced degeneracy. The racial idea as the basis of our state has already accomplished much in this respect. The most effective race-preserving measure is ... the greatest support of the natural defenses ..... We must — and should — rely on the healthy feelings of our Best and charge them with the selection which will determine the prosperity or the decay of our people ... [*in Z. Agnew. Psychol. Charakterkunde, 59,2,1940*]

Thus, it would appear, science warrants society's erecting social prohibitions in order to replace the degenerated innate schemata for racial purity. Lorenz's " scientific " logic justified Nazi legal restrictions against intermarriage with non-Aryans. The wild extrapolations from domestication to civilisation, from ritualised animal courtship patterns to human behaviour, from species to races, are so gross and unscientific, the conclusions so redolent of concentration camps, that further commentary should be superfluous. Perhaps it is impolite to recall in 1972 what was written



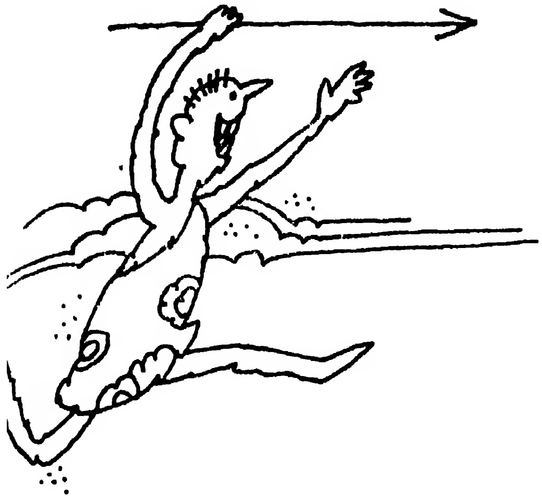
in 1940, but I, at least, find 1940 difficult to forget; indeed, I believe it should not be forgotten, lest we find ourselves in Orwell's 1984 for the very best of "scientific" reasons.

My position should not be misconstrued as condemning the study of comparative psychology or the search for biological determinants of human behaviour as though such efforts were inherently fascist. What I do inveigh against is the formulation of pseudo-scientific support for a priori social ideologies that are projected onto, not "found" in nature. Such pseudoscience ignores species differences and phyletic levels and misrepresents analogy as homology. For example, attack behaviour can be observed in organisms as varied as insect, bird, carnivore, ape, and man. In the first, it may be triggered by trace chemicals; in the second, by territorial defence, but only during the breeding season; in the third, by prey, but only if the appropriate internal state of arousal is present; in the fourth, by the appearance of a predator, if escape routes are unavailable and if the troop is threatened; and in man, by a mere verbal slur, if the social context and prior individual experience indicate attack as the socially appropriate response. The mere observation in divergent species of similar behavioural outcomes that fit the generic label "attack" justifies no conclusion about an underlying aggressive instinct, without detailed study of the conditions evoking, and the mechanisms governing, the behaviour of each. Such "explanations" reify a descriptive label that has been indiscriminately applied to markedly different levels of behavioural organisation, as though naming were the same as explaining.

Indeed, reports on animal behaviour fail to support the concept of an aggressive instinct as an independent motivational force analogous to hunger. That is, there is no predictable periodicity, no measurable changes in internal parameters (such as glucose concentrations in the blood), and no evidence of a "need" to attack in the absence of provocative stimuli. This is not to deny that the ease with which, and the circumstances under which, attack is elicited differs among species, nor that hormones, notably androgens, may have a profound impact on the probability of a fight rather than a flight response in higher organisms. The characteristics of the species, the genetic endowment of the individual organism, its prior experience, and the immediate stimuli interact to produce the behavioural outcome. Similar outcomes may result from quite different underlying mechanisms; meaningful comparisons become possible only when the mechanisms have been identified.

Is behaviour preformed?

Examples could be multiplied. At the most general level, the problem stems from a telic orientation: behaviour is "explained" by its outcome, rather than by an analysis of its ontogenesis. The cause is assumed to exist preformed in the organism as an "instinct" or innate pattern of behaviour. The Platonic ideal is immanent in the organism. But where is it, when does it appear, and how does it come into being? Not even the most ardent instinctivist would any longer argue that the "instinct" for aggression or courtship rituals or nest building is in the fertilised egg. Yet it is confidently asserted that it must have been precoded and ready to go because it appears without any apparent requirement for prior learning.



Let us agree: behaviour, like structure, is under genetic control. Animals of two species, reared in an identical environment, will nonetheless behave differently. The argument for innateness — in the sense of an inherited component — is compelling when the distribution of a given characteristic in an offspring generation can be predicted from a knowledge of its distribution in the parent generation and the pattern of mating in that generation. However, the genetic evidence does not warrant the other sense in which innate is used — that is, developmental fixity, an imperviousness to environmental influences. Environment influences development by mechanisms that need have nothing to do with learning. For example, certain mutations in wing and eye structure of drosophila are temperature sensitive; if the eggs are maintained at 18 °C, the wing or eye develops normally, despite the presence of the mutant gene. This is hardly "learning," but it is evidence that expressivity depends on the environment. It does not make the characteristic any less genetic that its phenotypic expression is modified by temperature. But, by having discovered an array of such factors, the investigator has made a start at identifying the biochemical mechanisms underlying the action of genes. The central issue in the study of development is the problem of the interactions among the programmed but modifiable unfolding of the genome, its cellular envelope, and the surround. If the nucleus of a frog's intestinal cell transplanted into an enucleated frog's egg gives rise to a normal animal, then for all of the phenotypic differences between cell types, they share, as we knew they must, the same genetic apparatus, but an apparatus whose expressivity is under cytoplasmic as well as nuclear control.

Even in closely related species, differences are more revealing than similarities in elucidating the principles that govern behaviour. Consider the study of bird vocalisation, which, beyond its intrinsic fascination, may yet provide important clues to the understanding of sound imitation in man. It is a graphic example of a behavioural characteristic that displays remarkable ontogenetic differences in closely related species. Song sparrows, isolated from conspecifics and foster-reared by canaries, nonetheless acquire their own song. Yet meadowlarks, similarly isolated as fledglings, acquire the song of the particular foster species: wood pewees, yellowthroats, or red-winged blackbirds. Still different is the white-crowned sparrow, which must hear the adult model of its song during a "sensitive period" of development in order to acquire it; nonetheless, if the fledgling white-crowned sparrow is simultaneously exposed to conspecifics and to two sympatric species, it "learns" only its own song. Once learned, the song persists, even if the adult is isolated. In the case of the goldfinch, the adult bird is able to learn new flight songs from other species. These few examples merely hint at the complexity of a growing field of inquiry. Precise attention of differences among species, the interrelationship of those differences with the ecology of the species, and the ultimate identification of the underlying neuromechanisms are what we will require for models that may have heuristic value in studying imitation behaviour in man.

Language: a universal human trait

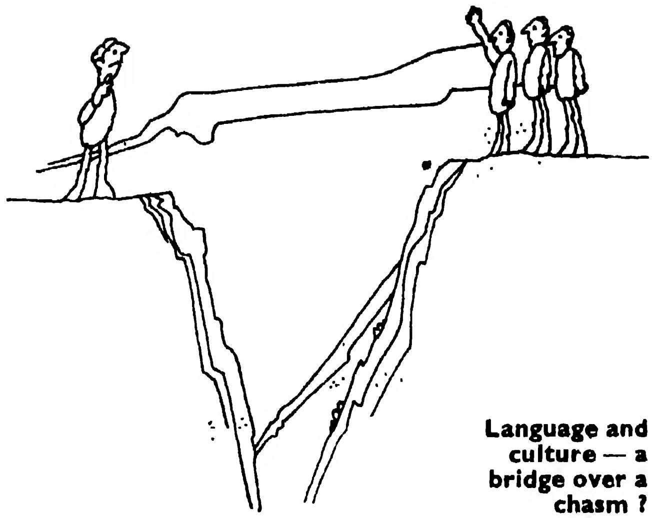
Man's biological equipment is now, if ever, an essential topic of study. That equipment evolved over the 5 million years which elapsed between the australopithecine homonids and *Homo sapiens;* it provided the means for survival in an environment not yet altered by artifacts. The spread of our species and the rapid multiplication of our numbers in the past five millenia attest to the adaptability of that biological equipment to circumstances that did not exist when it was elaborated. It is becoming painfully evident that the changes we have wrought in the past five decades threaten our continuing survival under conditions of an exponential rate of population growth. It now becomes necessary to ask: How adaptable is man? Is mere perpetuation of the species, without concern for the quality of life, a sufficient criterion for man, even if it has been so for nature? Man's intelligence permits him the conscious choice of goals and

so differentiates him from the rest of animate existence.

How, then to discern the nature of man? Two general approaches suggest themselves — the comparative and the developmental. In the first, we compare and contrast the characteristics of men and women in the diverse societies that people this planet in the hope of extracting common denominators that express man's "essential nature"; in the second, we study the interaction between the infant and his social and biological environment as he grows to adulthood.

One trait common to man everywhere is language; in the sense that only the human species displays it, the capacity to acquire language must be genetic. As Chomsky has pointed out, among the unique aspects of human language learning are the child's ability to infer syntactical rules from a limited set of input samples and, in consequence, his extraordinary capacity to generate grammatical sentences that he has never heard. The language he speaks is determined by the language he hears, but the capacity for language must be a consequence of the genetic programming of brain networks as these respond to maturation and experience. Languages, insofar as they have been studied, appear to share fundamental structural characteristics, a universality that argues for an as-yet-to-be-identified basis in common structures in the central nervous system. Recall the example of the white-crowned sparrow, which, though it must learn its song, is structured in such a way that its neural networks resonate only to a restricted set of external harmonic sequences. The data of linguistics suggest the possibility of a similar restriction on the form of language and the nature of grammatical structures; they imply limited variability in the neural schemata underlying language structures. Further refinement in our knowledge of these cognitive universals may yet enable us to propose models of neural mechanisms, which must then be sought experimentally.

Benzer has brought the tools of genetic analysis to bear on behavioural mutants in drosophila. By the ingenious use of mosaics with phenotypic characteristics that permit the morphological identification of individual cells that carry or lack the mutant gene for phototaxis, he has found the source of the behavioural deviation to be structural abnormalities in the affected eye. In flies in which mosaicism is present within a single eye,



Language and culture — a bridge over a chasm ?

histological techniques and single cell recordings can specify the deficit even more precisely. Cellular markers "provide powerful techniques for tracing the details of cell lineage during development, as well as genetic dissection of the functioning nervous system". Even the limited complexity of the drosophila's central nervous system defies analysis by current techniques, but an important beginning has been made in relating genetically determined behavioural differences to underlying physiological mechanisms.

The diversity of human culture

If language be one of the common features of human culture, even more remarkable are the diverse behaviours that cultures shape and are shaped by. What is labelled "masculine" in one culture and ascribed to the nature of maleness is regarded as "feminine" in another. Children are permitted uninhibited sexual expression and yet become monogamous adults in one culture; in another, preadult sexuality is heavily censored, whereas adult monogamy is privately violated while it is publicly proclaimed. Child care may be the responsibility of the nuclear family or of the group. The same Netsilik Eskimos who are loving and devoted parents can allow a female infant who is not "spoken for" in a prearranged marriage to die unattended and ignored if she is not given a name and is thus, by definition, not yet human. The phenomenon of war is unknown to one society, appears in a second only under environmental stress, but is a lethal "game" without apparent material benefit in a third. Indeed, if we were to permit ourselves the argument that the more "primitive" the

society, the more true to man's original nature the behaviour displayed therein, we should have to conclude, as did Sahlins that " war increases in intensity, bloodiness and duration... through the evolution of culture, reaching its culmination in modern civilisation ". However agreeable, the argument for the pacific character of natural man, uncorrupted by the social order, is inadmissible; culture is as complete and complex in contemporary hunting and gathering tribes, despite their primitive technology, as it is in our own — man is man only in society.

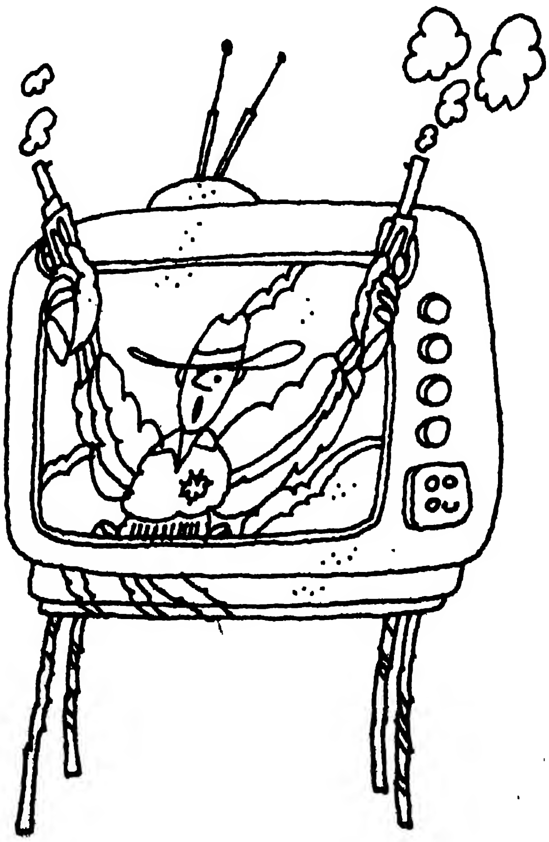
What is striking in this very partial inventory is the remarkable diversity of the human behaviours evoked by various but viable cultures. If we explain the murderous raids of Brazilian Indians on the basis of an innate aggressive instinct, we shall have to invent an involved theory of repression, reaction formation, and sublimation to account for the peacefulness of the Eskimo. Would it not be far more parsimonious to begin with the assumption that men are by nature neither aggressive nor peaceful, but rather are fashioned into one or another as the result of a complex interaction between a widely, but not infinitely, modifiable set of biological givens and the shaping influences of the biological environment, the cultural envelope, and individual experience?

Violence pays!

The very ubiquity of violence in Western society, however we explain its genesis historically, guarantees that children are surfeited with opportunities to learn violent behaviour! The child sees that violence pays off; he is provided with adult models of violent behaviour with whom to identify (television pales beside real life). Violence as an appropriate response to the resolution of intergroup conflict is sanctioned by national leaders. Reflect: the President of the United States intervened to prevent the immediate imprisonment of Calley, an officer convicted of mass murder in Viet Nam by a jury of combat veterans. Consider: the Attorney General of the United States declined to press charges in the Kent State student murders. What are the ethical values these actions by national leaders convey? When violence is sanctioned, it will increase. It can be expected to generalise to situations not "intended" to come within official pardon. Learning may not account completely for human aggression, but the social forces in contemporary society that encourage its development are so evident that preoccupation with hypothesised biological factors is almost quixotic.

Emphasis on the very marked differences among cultures may obscure what has been, until recently, a conservative tradition within each. Children reared within a particular value system could expect to complete their days within that system. Values now change so rapidly that what a child is taught by his parents may no longer be functional when that child becomes an adolescent, let alone an adult. However wide the range of behaviours man can exhibit — evidenced by the comparison of one society with another — the task of developing adaptive attributes is very different when radically changed behaviours are required within an individual's lifetime rather than over the history of a people. The question now becomes, not how malleable is man, but how much change can a man undergo and still maintain his psychic integration?

Here we lack empirical data; there is no precedent for such rapid change. We confront the fundamental relevance of studies of child development. In a stable society, the price demanded by acculturation may or may not have been burdensome, but clearly it was



bearable, or else that society would not have perpetuated itself. Studies of child development were important even then, if only to learn how to mitigate those burdens. But if we are to enable our children to cope with a world whose present shape we barely comprehend and whose future configurations we can only guess at dimly, then we are embarked on an enterprise that is the very keystone of the sciences of survival.

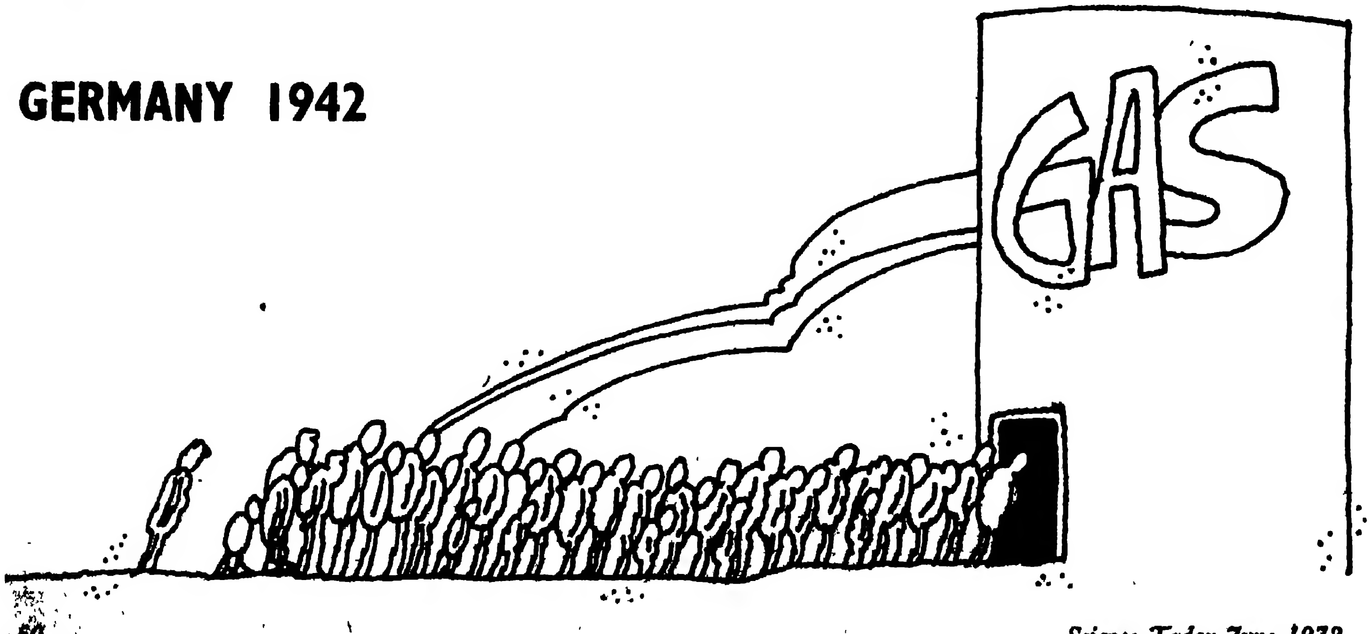
Man as his own chief product

I will forego detailing what we already know and ignore at the peril of the next generation: that the rapidly growing brain of foetus and infant is excruciatingly dependent on the adequacy of its nutrition; surely, no further amassing of scientific facts is needed to justify international commitment to the protection of the unborn and the newly born. What has become equally evident is that the nutriment the growing brain requires is affective and cognitive as well as alimentary. The extraordinary dependence of the human young upon adult care and caring provides both an unparalleled opportunity for mental and emotional development and a period of vulnerability to profound distortion by neglect. Infants in orphanages lag markedly in development, despite normal food intake, if denied a responsive human environment. There are indeed gaps in our knowledge of this early developmental sequence: just how much stimulation is optimal, just what balance is to be struck between gratification and denial, just what is the best mix between social interaction and time to be alone? Yet the outlines are clear enough to allow no excuse for what we permit to befall defenceless children, who suffer from the contumely we visit on their parents. Each infant differs from the others: no two, except for identical twins, share a common genome, and even identical twins may differ phenotypically because of gestational inequalities. We do not understand individual variability sufficiently well to fashion optimal environments for each child, but surely this does not mitigate our failure to provide at least those general requirements shared by all children.

Ignorance, as well as lack of commitment, becomes a limiting factor when children reach the years of formal education. The shortcomings of available theories of learning constrain our ability to respond to individual differences in the way children fashion their personalities and cognitive styles. There may be much to be gained from comparative studies of animal learning — to be sure, we are primates ourselves, but primates of a very special sort. We are no less subject to classical and operant conditioning, to trial and error learning, and the like, but only we have the capacity for superordinate modes of verbal learning, and these require much deeper study than has been devoted to them. Our challenge is no longer transmitting solutions that have been successful in the past, but helping our children to acquire attitudes and sets for problem-solving that will enable them to meet undreamed-of challenges to their capacities.

We have done least well at the task of encouraging the development of humane values based upon the recognition that we are a single species. The idea of brotherhood is not new,

GERMANY 1942



but what is special to our times is that brotherhood has become the precondition for survival. It may have sufficed in the past to spur a child to learn for the sheer satisfaction of his own success. If we have listened to what our students are telling us, learning for personal embellishment or for the acquisition of virtuosity no longer satisfies a generation intensely aware of injustice and impermanence. Learning must become a social enterprise, informed by concern for others.

This it can become. Man is his own chief product. The infant who discovers that he can control the movements of his own fingers transforms himself from observer into actor. The child who masters reading unlocks the treasury of the world's heritage. The adolescent who insists upon a critical reexamination of conventional wisdom is making himself into an adult. And the adult whose concerns extend beyond family and beyond nation to mankind has become fully human.

By acting on behalf of our species we become men and women. In a world in which wars rage, in which repressive governments subjugate their peoples, in which the pursuit of personal affluence ravages in environment that must be shared by all, there can be no neutrality. Members of the university community carry a heavy measure of responsibility for the privilege accorded them; that responsibility is to pledge themselves to the service of man if knowledge is to be transformed into wisdom.

The study of man takes its meaning from involvement in the struggle for human betterment. Struggle it is and will be: privilege does not surrender easily; false belief is not readily dispelled. The optimism about man's potential I urge upon you is not the self-comfort of reading history as a saga of progressive liberation which will one day be complete. It matters, and matters dearly, to Vietnamese and to Pakistani, to American and to Canadian, whether that day comes sooner or later; whether it comes at all is not determined by history but by the men and the women who make history. This has been eloquently stated by the Cuban poet Padilla, who has recently been released from prison in his own country. The final lines of his poem " Important Occasions " read:

History's going to save us — we were thinking. Going
to save us — were we dreaming?

It wasn't all just uprisings, barricades, bonfires: in our
heads it was a dress of bubbling foam, a
Rhine maiden with clear eyes, smiling, standing
at the door, hand outstretched
toward a hungry and waiting people.

But there was no one in the door-way. Nor in the house.

Instead we stumbled. They shoved us inside. We broke
our teeth going in, got our jaw smashed.

We found tools and weapons and we fought, we struggled,
we worked and continued
fighting. But it's true, old Marx, that History is not
enough. Important occasions, man makes them.

It's a real, live man who does it, who masters it, who
will fight.

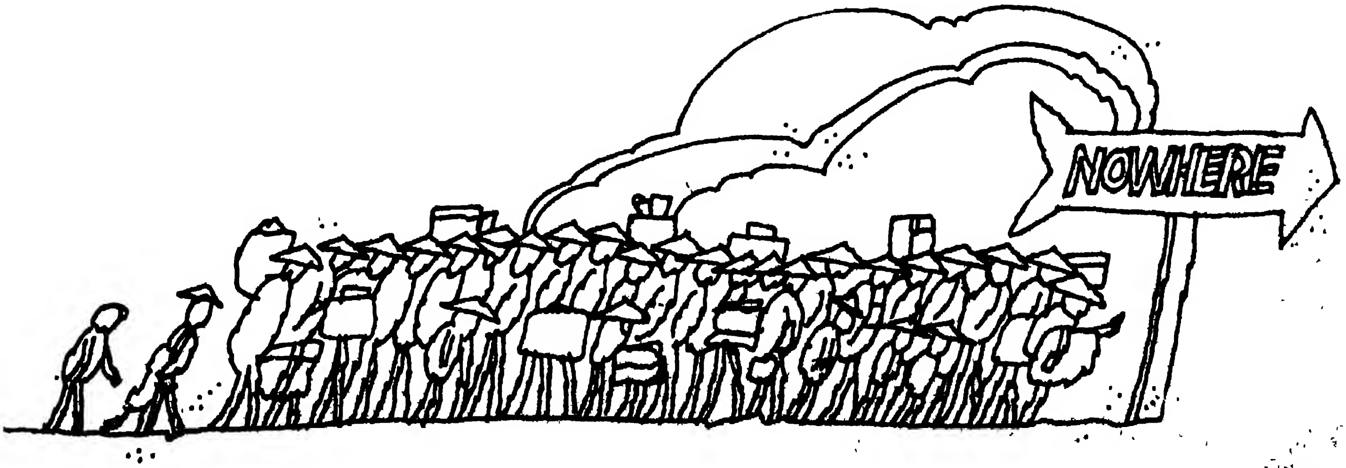
History by itself does
nothing, dear friends.

It does absolutely nothing.

[This article first appeared as "The *Human* Nature of Human Nature" in *Science, Vol. 176*, No. 4031, 14 April 1972. © 1972 AAAS.]

[SKETCHES BY SABIR]

VIET NAM 1972



AMEDEO AVOGADRO (9 June 1776): Like many other scientists, Avogadro has given his name to science.

Avogadro is best remembered for the hypothesis named after him, which he put forward to explain Gay-Lussac's discovery that all gases expand to the same amount when heated. Avogadro decided that all gases must contain an equal number of particles (now called molecules) at a given temperature. This hypothesis he advanced in a paper published in 1811.

This hypothesis also explains why, when water was electrolysed, the volume of hydrogen produced was twice the volume of oxygen. According to Avogadro's hypothesis, the water molecule contained two hydrogen atoms for every oxygen atom (not 1 : 1 as Dalton assumed). Dalton's assumption that oxygen is eight times heavier than hydrogen was also wrong; on Avogadro's hypothesis it is 16 times heavier.

But nobody was prepared to accept Avogadro's assumption that atoms of the same element should combine to form molecules; the almost universal belief was that atoms of the same element cannot combine to form binary molecules, as they must repel each other. Avogadro's biggest difficulty in making others accept his hypothesis was that he was unable to count molecules as they were too small and in constant motion, to be seen and proved to exist.

It was only in 1860, four years after his death and 51 years after the original publication, that at a conference of chemists from all over Europe a fellow-countryman of his, Cannizaro, pleaded for him in a brilliant paper expounding a system of weight determinations using Avogadro's hypothesis, and compelled others to take it seriously. It was also at this conference that the smallest possible particle of any substance existing by itself was defined as a molecule, thus clearing up the confusion about atoms and molecules.

Avogadro died on 9 July 1856.

SADI CARNOT (1 June 1796): Why are perpetual motion machines impossible? It was Carnot who proved why, in a memoir which, though it became part of the second law of thermodynamics, attracted little attention when it appeared (1824).

Sadi was the son of Lazare Carnot, a French general who appointed Napoleon Bonaparte to his first command, and who himself wrote a treatise on the efficiency of mechanical devices. The family's fortunes however declined after the defeat of Napolean, and Sadi who had joined the Army Corps of Engineers retired from it on half-pay at the age of 24. In retirement he took up the scientific studies that had interested him earlier, and wrote the memoir on which his claim to fame rests.

LOOKING BACK...

did the stars foretell?

According to Carnot, heat engines — and this included all the variety of engines then in use — operated simply by transferring heat from a hot body to a cooler body. Heat was equivalent to work, and wherever there is a temperature difference, motive power can be produced.

Carnot suggested that the efficiency of a heat engine or the maximum fraction of heat energy that could be converted into work depended on the ratio of the temperature drop in the engine to the original temperature, as given by the equation $\frac{T_1 - T_2}{T_2}$, where T_1 is the temperature of steam (in the case of the steam engine) and T_2 the temperature of the cooling water.

Carnot was the first to consider quantitatively the relation between heat and work. He was wrong however in accepting the caloric theory of Lavoisier, though this did not affect the validity of his results. He is rightly regarded as the father of thermodynamics or the study of the flow of heat. He died of cholera on 24 August 1832, when he had hardly crossed 36 years.

LORD KELVIN (WILLIAM THOMSON) (26 June 1824): Lord Kelvin was a precocious child. He matriculated at the age of 10 and before he was 20 his paper on electrostatics made him one of the select top scientists of the day. Though most known for his practical inventions — like an improved mariner's compass, tidal gauge tidal analyser, tide predicter, simplified tables for determining ships' position at sea and fathometer, he made significant contributions to electric oscillations and the theory of thermodynamics.

Kelvin's greatest work in theoretical physics was his contribution to thermodynamics. To resolve the conflict between Joule's results and Carnot's work, he put forward what he termed a dynamical theory of heat (1851). He deduced from Carnot's work the proposition that all energy tends to dissipate itself as heat, that it "runs down" into an unusable form. He pictured this continuous "degradation" as a sign that the whole universe was running down. This is another form of the second law of thermodynamics, put forward by Clausius, and of the latter's concept of "entropy", according to

which, in a closed system, such as the universe as a whole, the availability of energy for conversion into work was steadily falling. Eventually there would be nothing but a universe at complete temperature equilibrium — a state known as " the heat-death of the universe ".

Lord Kelvin proposed in 1848 that the energy of motion of a gas's molecules reached zero at —273°C., that this was true for all matter, and that this temperature be regarded as absolute zero, the ultimate in low temperature. The new scale of temperature where zero means —273°C., which he proposed, is named after Kelvin.

Although Hertz is usually credited with performing the most important early researches in electric oscillations and waves in 1888, it was really Kelvin who laid the foundation of the theory of oscillations by studying the oscillatory discharges of a Leyden jar. He used copper cable of highest conductivity for telegraphic signalling by wires. He also invented instruments like a mirror galvanometer and a siphon recorder which almost spontaneously responded to the minutest change in the cable current. It was on the basis of such studies that the first Atlantic cable was successfully laid. He also introduced Bell's telephone into England. He was knighted in 1866 for these achievements.

Kelvin died on 17 December 1907.

BLAISE PASCAL (19 June 1623): The young Pascal's father wanted him to study languages, not mathematics. Later he found abundant proof of the boy's great gift for mathematics, and relented.

In mathematics, Pascal is best known for laying the foundations of the theory of probability, the study of mass-scale random events repeatedly occurring under certain circumstances. In this he was inspired by a gentleman gambler who was losing large amounts in betting. He showed that even in uncertainty there is an element of certainty: of every hundred tosses of a coin, roughly 50 will be heads and 50 tails.

In physics he was the first to show the link between the mechanics of fluids and rigid bodies. Pascal's Law states that pressure applied to an enclosed fluid at any point is transmitted undiminished in all directions and at right angles. This is the basis of the hydraulic press, in which a small piston, pushed down a cylinder filled with fluid, is able to push up a larger piston with a much greater force than is applied to the small piston. This is similar to the principle of Archimedes' lever, in which the multiplication of the force applied is made possible by moving the lever a greater distance.

Pascal decided to test Torricelli's view that the atmosphere had weight. Because he himself was chronically ill, he got his brother-in-law to climb up a mountain with two barometers. The brother-in-law found that after climbing a mile the mercury column in the barometer dropped three inches. This rightly led Pascal to think that the weight of the mercury column was balanced by the weight of air on the surface of the mercury in the dish.

As scientists occasionally do, Pascal became a mystic in his last years and declared that reason was an insufficient tool for understanding the universe. He died on 19 August 1662, at the age of 39.

THOMAS YOUNG (13 June 1773): Having read the Bible twice before he was four, Young was not only precocious in infancy, but kept up the promise of his childhood in his later years.

Trained in medicine under John Hunter, this English physician was the first to show that it is by varying the curvature of the lens that the eye is able to focus on objects lying at various distances.

Young thought that colour perception might be due to the presence in the retina of structures which correspond to red, green and blue colours, respectively. This view of colour vision was later extended by the German scientist, Helmholtz who developed the Young-Helmholtz three-colour theory which says that human vision uses three basic colours — red, green and blue; every colour sensation is the joint effect of these three colours in different proportions, and that is why any colour can be produced by adding together red, blue and green, (called 'additive primaries'), with suitable relative intensities.

His work on light led him to challenge Newton's corpuscular theory. According to Young, colours are similar to sounds of various frequencies, and both sound and light are vibrations of waves. In his classical " biprism " experiment (1801) he made the discovery of the principle of interference: when two narrow beams of light are introduced through narrow openings and made to overlap each other they produce light and dark bands as each of them either strengthens or weakens the other. This phenomenon could be understood more easily if light consisted of waves, like sound. Thus he revived Huygens' wave theory of light, with its medium of ether — though with the difference that in his theory the waves were transverse and not longitudinal.

Young's interests did not stop with physiology and physics. He took up archaeology and was the first to make progress in deciphering hieroglyphics or the language of the ancient Egyptians.

Young died on 10 May 1829.

S. N. Munshi

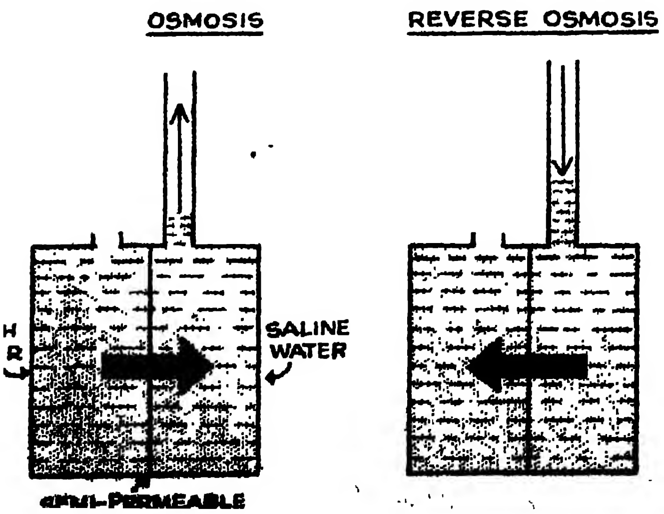
TECHNOLOGY NEWS

Clean water through reverse osmosis

OSMOSIS is a natural phenomenon in which a solvent flows across a semi-permeable membrane from a dilute solution into a stronger solution. If, for instance, water and a salt solution are separated by a semi-permeable membrane, the water diffuses across into the salt solution. This process can be reversed if we can apply a pressure greater than the pressure involved in osmosis (osmotic pressure) on the stronger solution. Called reverse osmosis, pure water from the salt solution will now flow across the membrane into the water cell, leaving behind a more concentrated salt solution.

That gives the reverse osmosis technique varied applications. As a desalination process, it can be used in desalination of brackish water to provide drinking water, particularly in areas like Rajasthan and coastal Gujarat where the water is generally saline. It can also be used for producing salt-free industrial water, for industrial and sewage treatment, etc. As a concentration process, it can be used for recovering chemicals from industrial effluents such as dyes from textile wastes, silver from photographic solutions, enzymes from pharmaceutical wastes, etc, for separating chemicals, and for concentrating pharmaceutical preparations and liquid foods such as milk products.

But the main problem here is the preparation of a suitable membrane. The Central Salt and Marine Chemicals Research Institute, Bhavnagar, has now developed a semi-permeable membrane from cellulose acetate. The membrane is cast from a ternary mixture of cellulose acetate, formamide and acetone; the solution is then evaporated, treated by cold water immersion and annealed. The CSMCRI process has been patented and the patent is being used by three private engineering firms.



Normally, distillation is used in desalination. While distillation may be preferred when the salt content is very high, it consumes the same amount of energy even at lower salt contents. Since the pressure needed for reverse osmosis depends on the salt content, the energy consumption is low — about 10 kwh per 1,000 gallons of brackish water with 5,000 parts per million (ppm) salinity. Besides, the process involves no phase change, clears bacteria and viruses from water, and can handle solutions with different salinities. Equipment and maintenance costs are low.

Since the plant can be operated on a small scale, it can meet the drinking and irrigational water demands in certain isolated areas. The CSMCRI has been working its demonstration plant for the last six months. In experiments, brackish water with 5,000 parts per million total dissolved solids was converted into water with 600 to 800 ppm total dissolved solids at a feed-product ratio of 4 : 3 and an operational pressure of 50 kg/sq cm. The process became cheaper with increasing scale — Rs. 6·10 per 1,000 gallons at a plant capacity of 10,000 gallons a day and Rs. 4·70 per 1,000 gallons at 100,000 gallons a day.

But the cellulose acetate membranes have certain limitations as far as industrial effluent treatment is concerned. This is a growing problem in most of the countries. Some of the effluents, particularly from fertiliser plants, contain such high amounts of chemicals that they need to be treated before the recovery of water. Studies are being done in many countries to use the reverse osmosis technique in such cases. Experiments at the CSMCRI showed that while the process can be used for ammonia plant wastes, provided the waste is not highly alkaline, it cannot clear urea except in very small quantities. Oils, suspended solids and highly acidic wastes damage the membrane. In a paper read (by M. D. Patel, R. S. Parmar and R. D. Ahuja of the Gujarat State Fertiliser Co Ltd, Baroda, and D. J. Mehta, A. S. Kane, M. V. Chandrasekhar and H. N. Shah of CSMCRI) at a recent conference, the cost of ammonia plant effluent treatment was given as Rs. 3·42 per 1,000 gallons for a pilot plant with 50,000 gallons capacity a day. Waste reduction was about 90 per cent.

THINGS WE USE

SPECTACLES

SUMATI K. SAMPEMANE

IT was Dorothy Parker who wrote "Men seldom make passes (oblique) At girls who wear glasses". She wasn't the only one to take a dig at bespectacled girls. Four-eyes, owl-eyes — such appellations are common enough. And the association between thick, bulging lenses and uninteresting studiousness is age-old.

The trouble with spectacles is that short-sighted youngsters often have to change them periodically as their eye., seem to get steadily worse. The common theory explaining this phenomenon is that, in growing children, the eyeball keeps elongating till the period of growth is over. Then vision problems are shelved — till the onset of middle age. Many myopics (short-sighted people) think they can dispense with spectacles at this time as they feel their long-sight will counteract their short-sightedness. But that unfortunately is mere wishful thinking. Presbyopia (long-sightedness) does overtake them — though a little more slowly — and they must then wear their extra two-eyes.

The normal human eye is an almost perfect sphere, slightly bulging in front. Its movements are controlled by a set of muscles. Within it lies a crystalline lens which thickens or flattens to look at objects near by or far away. It projects the image onto a light-sensitive screen, the retina, from where the impression is carried to the vision centre of the brain by the optic nerve.

It is when the eyeball is misshapen — with an irregular curvature or an imperfect sphere — or when there is muscle imbalance or loss of power of accommodation of the lens or a high refractive index in the eye liquids that the vision gets blurred or faulty. Such faulty vision can be rectified with the judicious use of spectacles.

The normal eye should be able to read correctly the standard eye-test chart, comprising of different-sized alphabets, dots or lines, from a distance of six metres. This test, along with certain other ophthalmic tests, determines the power of the spectacles needed. The power also depends on the distance between the lens and the eye. This distance should be around 15·7m.

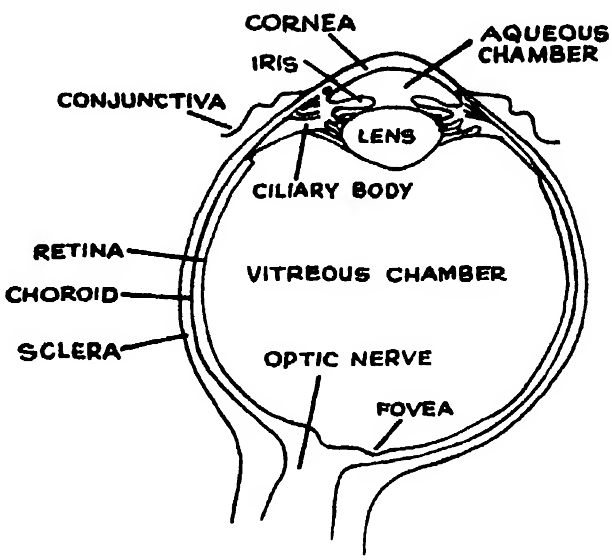
In youngsters, the usual complaint is short-sightedness or myopia. In this case, a person cannot see distant objects (beyond six metres) as the clear image is focussed by the crystalline lens at a point very much ahead of the retina. There are several causes of myopia — elongation of the eyeball, an unusually high curvature of the cornea or lens or both, a high refractive index of the aqueous humour, a shallow anterior chamber or a high total index of the lens. The most common is the elongation of the eyeball. It creates a state known as axial myopia. Since rays of light from a distant object reach the myopic eye and converge and form an image in front of the retina, a pair of negative-powered spectacles (diverging lenses) are required to correct the vision so that the rays travel further before they are focussed.

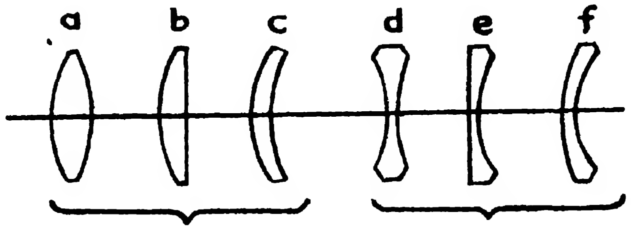
The other complaint, hypermetropia or hyperopia, is similar to the long-sight problem of the middle-aged man who cannot read without glasses. In this case, the eyeball is flattened and light rays from a nearby object are not in focus when they reach the retina. Their focus lies at a point beyond the retina — a point where the normal retina should have been. The defect can be overcome by further converging the rays with a positive-powered lens.

Astigmatism is yet another eye defect. In this condition, the curvature of the eye differs at different parts of the eye. The vision, though clear in one particular plane, is blurred in the plane perpendicular to it. To correct this defect, the lens must be powered only in that particular axis. This can be achieved with the use of a cylindrical lens or a toric lens. A toric lens is one in which the curvature in the two perpendicular planes is different.

When the muscles moving the eye become weak, the vision becomes poor. To see an object, both eyes focus simultaneously on it. In some cases, the muscles controlling the movements of each eye fail to coordinate. This results in two distinct images being produced instead of one. To correct this muscular imbalance requires the incorporation of prisms in spectacle lenses.

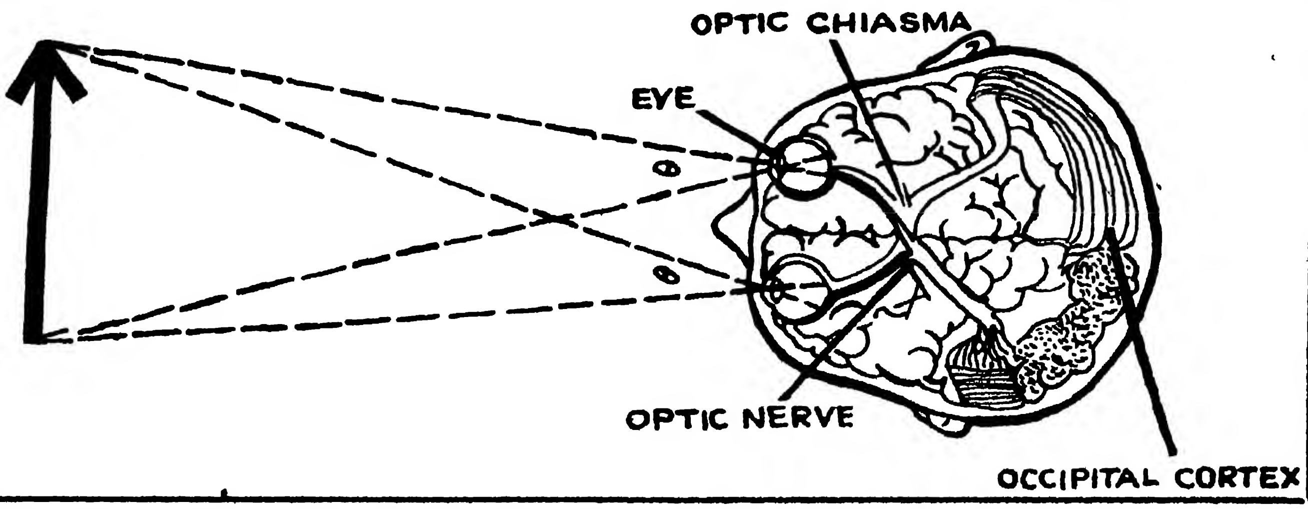
Lenses of very high magnifying power are used to aid the cataract-operated people who flounder in an almost totally blurred world. The natural lens, which gets clouded, is removed and a high-power lens like a telescopic lens is used. This consists of a system of two lenses —





The human eye (left, top) is a four-layered spherical organ with a slight bulge in front. It is divided into two chambers. The anterior chamber contains the aqueous humour, a liquid, and the posterior chamber contains the vitreous humour, a jelly-like substance. The crystalline lens, which separates the two chambers, is capable of elongating and flattening by means of the ciliary muscles to enable light from either near or distant objects to focus on the light-sensitive screen called the retina. The fovea is the spot on the retina where vision is most acute. The blind spot is another spot on the retina at which there is no vision. This is the spot where the optic nerve enters the retina. The optic nerve carries the impulses to the brain. The impulse is an inverted image of the object. The two eyes work in conjunction to ascertain the depth or distance of an object. This judgement is gained by a mental assessment of the difference between the two images formed.

Lenses are used to correct defects in vision. Lenses are curved transparent materials. They change the path of light passing through them and make rays meet at a real or imaginary focus. Convex lenses converge rays while concave lenses diverge them. The focus of a convex lens lies at the meeting point of the convergent rays. In a concave lens the focus lies at a point where the divergent rays would meet if extended backwards. The figure (left, centre) shows a biconvex lens, a planoconvex lens, a meniscus lens, a biconcave lens, a planoconcave lens and a meniscus lens.



one convex and the other concave. The concave lens has a focal length shorter than the convex lens that is fixed firmly on a metallic frame. The entire lens is rather cumbersome and conspicuous. Sometimes plastic lenses are used to lessen the weight problem.

When lenses were first used to aid the eye they were mainly the biconvex lenses used by the aged to read. As spectacles gained popularity, the biconvex and biconcave gave way to the planoconvex and planoconcave lenses. These, in turn, were later replaced by the meniscus lenses. In the latter, both surfaces are curved in the same direction and the power of the lens is the difference in powers of the two surfaces. Thus, if a positive-powered lens is required, a high positive power is ground on one side and a negative power (which, on being

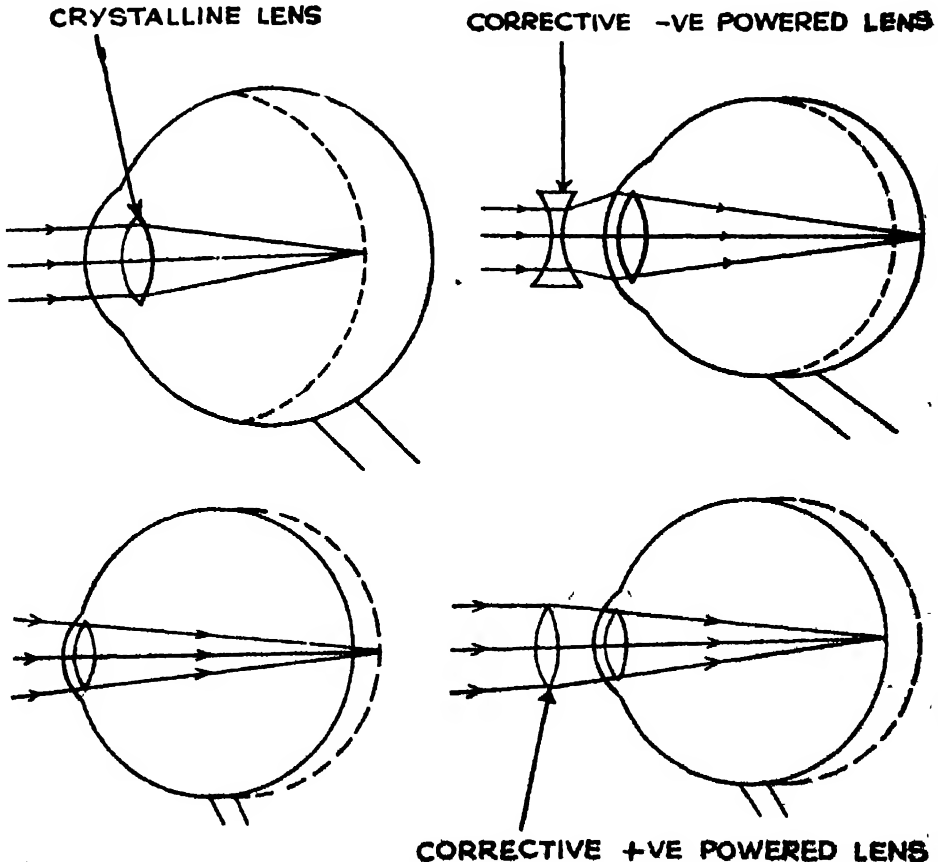
added to the power on the first surface, gives the required power) is ground on the opposite surface. For example, to get + 2, + 8 is ground on one surface and — 6 on the other. Similarly — 8 and + 6 would give a negative power, — 2.

The distance between the lenses mounted on a frame depends on the distance between the pupils of the person. The distance between the optical centre of the two lenses of the spectacles should be equal to the inter-pupillary distance if the spectacles must function well. If this adjustment is not made, headaches, eye fatigue and blurred vision result.

Spectacle lenses are ground from high grade optical glass — crown glass of refractive index 1·523. Plastic is used when unbreakable lenses are desired. But plastic lenses get scratched easily and have therefore to be changed often.

Often, lenses are tinted during manufacture with the addition of certain chemicals. The purpose is not to make them more opaque but to cut out glare. Polaroid sunglasses, for example, have a light-filtering property which cuts out the glare of sand, snow and water. In powered polaroid glasses, a polarising sheet of plastic is pressed between the two powered glass lenses.

The blank glass is ground on each side on rotating steel dies, using an abrasive to give the desired curvature. It is then smoothened and its transparency is checked before it is cut to the required size and shape for mounting on the frame. For a bifocal lens, the blank is available with a powered flint glass button annealed into the crown glass blank. The curvature of this flint glass button is equal to the difference in power of the reading segment and the distant vision segment. Benjamin Franklin was the first wearer of bifocals. His glasses consisted of two separately ground lenses flattened and cemented base to base. But this type was not long-lasting as the cementing glue deteriorated and dust accumulated in the crevice. Later, a flint glass button with a higher refractive index was glued onto the blank. This eventually gave way to the flint glass button being sunk in the blank by heat. The modern-day bifocals have no demarkation line between the reading and distance vision sections. The powers are ground on a single lens with the change taking place gradually.



Myopia : In this eye defect, the rays of light from a distant object do not focus on the retina but at a point before the retina. A concave lens that diverges the rays of light can correct the defect and make light rays focus on the retina.

Hyperopia: In this eye defect, the light rays from a near object focus beyond the retina. A convex lens can help converge the rays further to make them focus on the retina

Trifocal lenses are similar to bifocals. But they have three powers — for distant, medium and near vision. The size of the reading section (near vision) and the shape depends upon the requirements of the wearer — a larger reading section for one who needs to read more, a smaller one for a field worker, a wider one for one who has to look at a wide range of objects at close distance — so that the head movements can be minimised.

History is not very clear about the origin of spectacles. Magnifying glasses were used for reading by the aged many centuries back. Roger Bacon wrote of the earliest spectacles used around 1268. But the Chinese seem to have been a step ahead all along — they appear to have had their spectacles since the tenth century. Originally spectacles were made of quartz or beryl. But demand soon outweighed supply and glass became the raw material. It is not just the lens that has evolved down the ages. Frames have too. Starting from a primitive handle to hold the glass to one's eye they have moved on to clips to fit on to the bridge of the nose — the pince nez — to the present-day spectacles. And, of course, fashion has its influence on the shape, size and colour of frames. Today's go-go glasses cover not just the eyes but a large part of the face too. They come in saucer sizes, round-shaped, square, oblong, hexagonal and what not. And their colours are borrowed from the rainbow.

At first spectacles were used solely for reading. People seldom wore them in public for fear of ridicule. In fact, in France the wearing of spectacles was considered a breach of etiquette right down to the 18th Century. But their advantages soon outweighed social displeasure and spectacles were accepted into the public fold.

Not for long it seems. The spectacles' days are numbered. Now contact lenses have entered the field. Contact lenses are small and invisible and fit snugly round the wearer's eyes. There are two types of contact lenses — the haptic or scleral lens which covers the entire visible portion of the eye and the corneal (or micro or contour) lens which covers only the coloured area. Also, the power of contact lenses needs changing less often than spectacles. Being small, they are easy to carry around. Still, their greatest advantage lies in their cosmetic value. They do not fog in cold climates as do ordinary spectacles. But they are not without their disadvantages — the high price being, at present, the greatest one. People take time to get used to having a foreign particle in their eyes. And since bifocal contact lenses are as yet not in common use, a pair of spectales have to be used over them for reading purposes. Their small size could also be a disadvantage, especially for careless people who always misplace things. And finally, if the eye waters too much due to irritation, the lens may be washed off. To the woman who uses her tears to advantage, contact lenses could be a hindrance. Which all goes to show that spectacles are yet a long way off from becoming museum pieces.

BRAIN TEASERS

Polished off

Mrs. Pathak polished all the surfaces in three of her rooms. She took half as long again to do the second room as she did for the first and a quarter as long again for the third as for the second. Altogether she took ten minutes less than six hours.

How long did the first room take her?

Holiday haunt

He didn't like to tell his wife, but he remembered, in the train, that he'd left the hot and cold water taps running. He knew the hot tap would fill the bath tub in 30 minutes, the cold tap in 20. He had left them running full on. "Never mind," he mused. "I left the plug out, and the drain empties the bath in 15 minutes. We stop at the next station and I'll have time to ring up old Madhu and ask him to see to it."

By the time they'd reached the station, 40 minutes would have elapsed since turning on the taps.

What is the extent of the disaster?

Cheese act

When the price of cheese sandwiches was raised by 15p per half dozen, our canteen manager got two less for Rs. 2·10 than he'd have got before the rise in price.

What was the old price per dozen?

(Solutions next month)

[See p. 60 for solutions to last month's Brain Teasers].

YOU TOO CAN DO IT

Electronic Windscreen Wiper Control

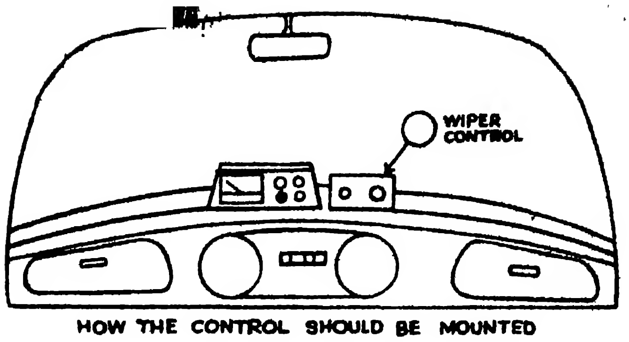


Fig. 1

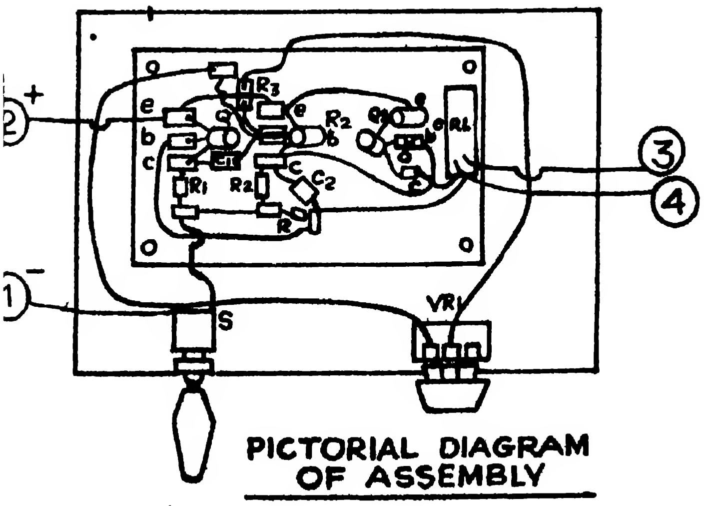
A slight drizzle on a monsoon day is irritating to a driver. He just cannot keep his windscreen wipers on. If he does they soon rustle and squeak and bounce because there is not enough water on the windscreen to keep the wipers well lubricated. Even if his car has wipers with variable running speeds he cannot solve the problem as the requirement in this case is intermittent operation of the wipers, not changing speeds. In such a situation, the best bet is to turn the wipers on and off periodically. But to do so manually is a tiresome affair. And dangerous too, for it involves dividing one's attention between driving and switching the wipers.

This is where an automatic wiper switch comes in. The unit consists of a circuit board which supports an " astable " multivibrator, an amplifying transistor and a relay. The entire circuit is housed in an aluminium minibox which also supports the potentiometer VR1 and the switch S.

If the unit is to be used, position the switch S to its second position. In this position, it will turn on the circuit. Now turn VR_1 until you get the setting (ON/OFF ratio) you need. For full speed operation, you should move S to its third position. Here the wiper motor will get its current directly from the battery.

The unit is not very expensive. It should cost between Rs. 20 to 25, depending on the parts you use. And in this respect it is important to use good quality capacitors for C_1 and C_2 to prevent any leakage of current. As the unit will be fitted inside the car — on the dashboard (Fig. 1) — it is not necessary that it be weatherproof (heat, cold, waterproof, etc).

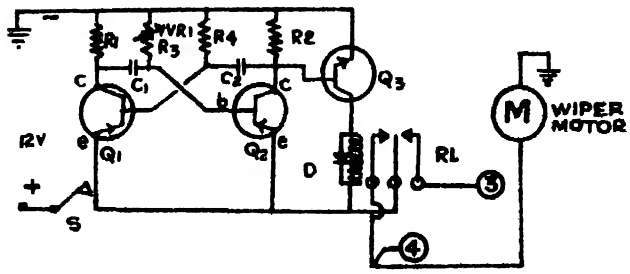
Begin by constructing the aluminium box. Then cut the circuit board to size, install

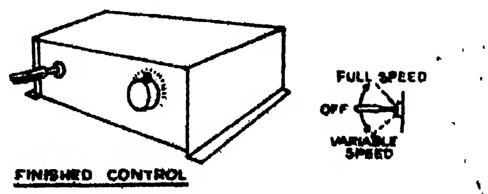


1) − TERMINAL
2) + TERMINAL
3) TO WIPER MOTOR
4) TO WIPER MOTOR

USE ANY ONE TERMINAL, EITHER # 3 OR # 4 BUT NOT BOTH.

Fig 2. (left). Fig 3. (below). Fig 4. (bottom).





the push-in terminals and solder all the components onto their tags (Fig. 2). Then solder all the connecting wires to their appropriate terminals.

You should test the unit before installing it. To do this, put a 12V — 1 Amp bulb in the place of the wiper motor in the relay connection. And also take certain precautionary measures. Double check the connections, check the polarities of Q_1, Q_2 and Q and use a heatsink of suitable size for Q_3.

The working of the unit is not too complicated. The circuit uses an " astable " multivibrator consisting of Q_1, Q_2, R_1, R_2, R_3, VR_1, C_1 and C_2. When the switch S is connected, a voltage is applied to the circuit because either Q_1 or Q_2 starts conducting heavily. Only one of the transistors will conduct as the two conduct only alternately.

Due to the differences in gain of the transistors, one of them will conduct. If Q_1 conducts, almost the entire voltage supply is impressed across R_1. This effectively drops the voltage between the emitter and base of Q_2 which will, in turn, pass even less current thus raising the emitter-base voltage of Q_1 further. Q_1 thus conducts more. This goes on till Q_1 can conduct no further. At this stage, C_1 will keep charging via VR_1 and R_3. When it is charged, it allows Q_2's base current to flow. Q_2 now starts conducting while Q_1 stops as C_2 now charges up via R_2. This effectively drops the voltage across Q_1's base and emitter.

This process goes on thus enabling the multivibrator to keep its oscillation going. When Q_2 conducts, Q_3 also conducts. It pulls in the relay Rl, turning the wiper motor on. The ON/OFF ratio can be adjusted.

You will need:

Transistors: Q_1, Q_2 — 2SB75, AC125, etc; Q_3 — AC127. *Resistors:* R_1, R_2 — 2·4K ohm, ½ watt, carbon 10 per cent ; R_3 — 5K ohm, ½ watt, carbon 10 per cent; R_4 — 100K ohm, ½ watt, carbon 10 per cent. *Condensers:* C_1, C_2 — 100 mfd, 25 VW, DC, electrolytic. *Potentiometer:* VR_1 — 100K ohm. *Relay:* Any DPOT, 120 — 200 ohm resistance coil at 12V. *Switch :* S — SPDT Toggle switch. D — BY127. *Miscellaneous :* Case, knobs, hook-up wires, solder, terminal board, push-in terminals, etc.

F. Rehman

Solutions to last month's Brain Teasers

Boy or girl : If Ramu has two children, one of whom is a boy, there are three probable cases

Boy — Boy
Boy — Girl
Girl — Boy

Only in one case are both boys, so the probability that both are boys is ⅓

Shekhar's situation is different. His older child is a girl. So we have only two probable cases

Girl — Girl
Girl — Boy

So the probability that both are girls is ½

Eenie meenie mina mo.... There are many ways in which the cake can be divided into *n* pieces by *n* people so that each is satisfied he gets 1/*n* of the cake. In this solution, there is no piece of cake left out.

If there are five persons A B C D E and each cuts off what he thinks is 1/5th of the cake and keeps it as his share, then B, for example, can cut off a portion of A's share if he feels A has taken a larger slice. If B thinks A has 1/5th or less he will not object. C, D and E share the same privilege. The last person to touch the slice keeps it as his share. The others would be glad if the slice were less than 1/5th as it would mean there is more than 4/5th left. The remainder of the cake, along with the cut-off pieces, is then divided among the remaining four in the same manner, then among three. Eventually, when two are left, one cuts and the other chooses. This procedure can be used by *n* persons.

Rupees and paise : Let x stand for the rupees and y for the paise in the amount in the cheque. The problem becomes an equation: $100y + x - 5 = 2(100x + y)$. This is reduced to $98y - 199x = 5$. If this problem is solved by standard methods the lowest values in positive integers is $x = 31$ and $y = 63$. So the amount was Rs. 31·63p. The next lowest integers are $x = 129$ and $y = 262$. This is not possible as then y would be over 100.

SCIENCE TODAY

INDEX TO VOLUME VI

July 1971 to June 1972

(Figures in italics denote issue numbers)

Regular Brushing of Teeth and Massaging of Gums Check Gum Troubles and Tooth Decay.

Dentists say, the best way to keep gums firm and healthy is to massage them regularly. And, the best way to check tooth decay is to brush teeth regularly, night and morning, and after every meal, so that all decay-causing food particles are removed.

Teach your child to brush teeth and massage gums regularly with Forhan's. Because Forhan's toothpaste is specially formulated by a dentist.

Forhan's

the toothpaste created by a dentist

It's never too early to teach Forhan's dental care.

FREE! **Informative colour booklet on "Care of your teeth and gums."** For your copy*, please send 25p stamps (to cover postage) with the coupon, to Manners' Dental Advisory Bureau, Post Bag No. 10031, Bombay 1.

Name ______________________ *Age* ________

Address ______________________

____

*Please underline language wanted: English, Hindi, Marathi, Gujarati, Urdu, Bengali, Assamese, Tamil, Telugu, Malayalam or Kanarese.

S 36

101F-203 R

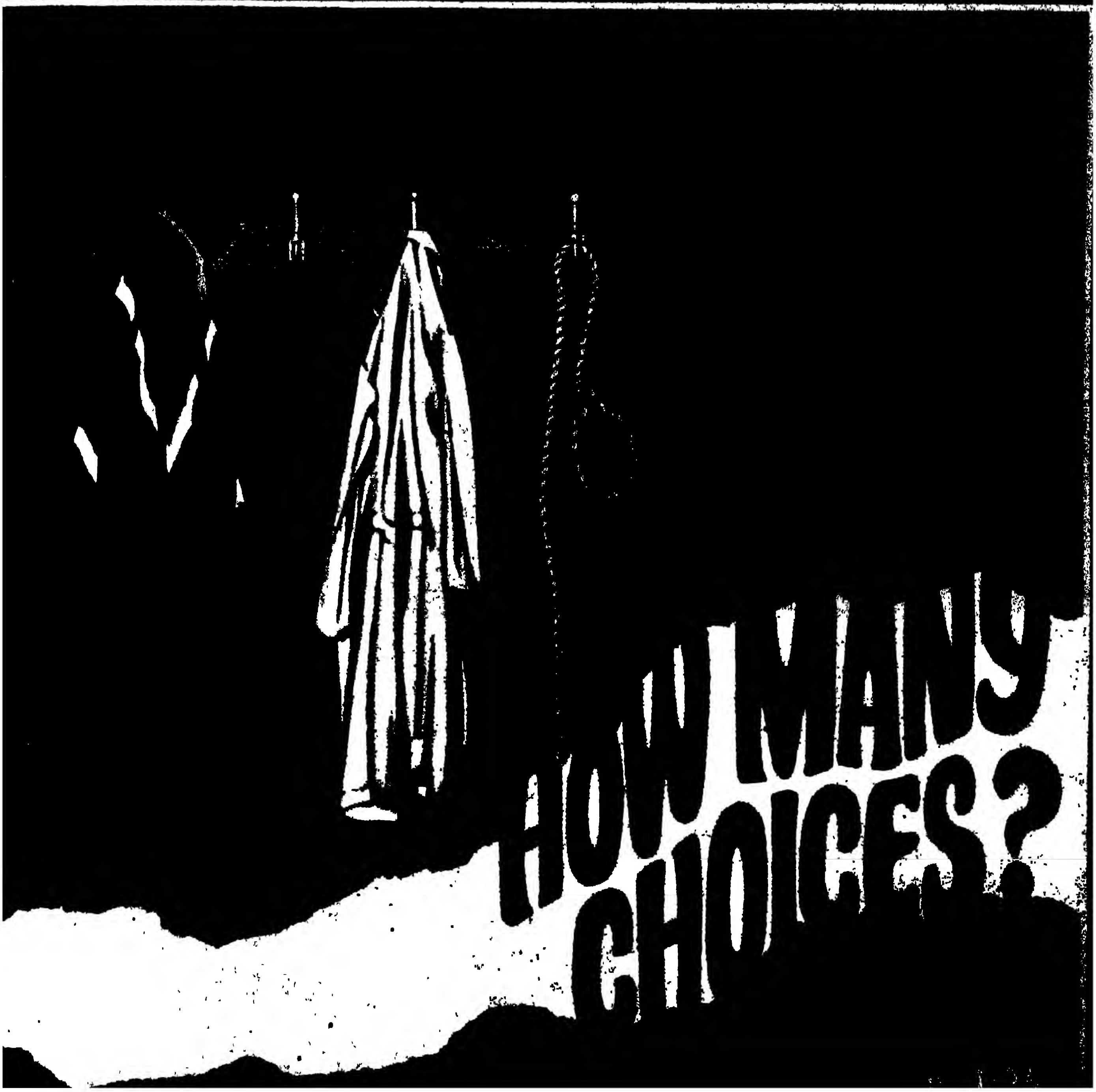
Regd. No. MH 1368

A TIMES OF INDIA PUBLICATION

JULY 1972

SCIENCE TODAY

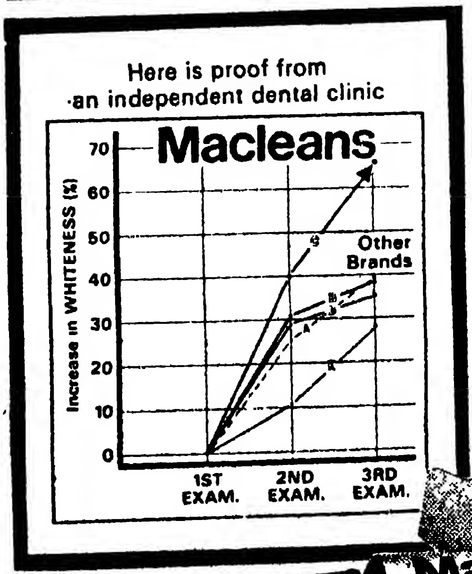
FOR EVERYMAN



We've got the proof

New Macleans freshmint

makes teeth whiter and healthier than other toothpastes



An independent dental clinic abroad tested leading toothpastes and conclusively proved that Macleans made teeth whiter.

Try the sparkling new taste of Macleans Freshmint. The proven way to make teeth whiter, healthier.

Macleans—acclaimed the world over
for making teeth whiter and healthier

New Macleans freshmint for whiter, healthier teeth

OBM/8092

Science Today

VOL. 7 NO. 1
JULY 1972

ARTICLES

Page 37

FEATURES

COVER

From university to the laboratory — they walk on dreams. Could they use the last peg for laurels? (Painting by Shabbir Diwan)

Rs. 1·25; 10p

Annual Subscription Rs. 12·50

EDITOR

SURENDR JHA

Printed and published for the proprietors Bennett, Coleman & Co., Ltd., by Uma Shankar at the Times of India Press, Bombay, India. Delhi Office: 7, Bahadur Shah Zaffar Marg, New Delhi 1; Calcutta Office: 13-1 and 13-2, Government Place East; London Office: 3, Albemarle Street, W.1.

bharati process goes abroad

FOR twelve years, he had gone knocking from door to door, trying to move the high powers. But the high powers wouldn't move. Or if they did, they weren't sure of their grounds. Yet he waited, pleading, persuading and hoping, till the seal of rejection was set firmly two months ago. Today, 57-year-old Iqbal Krishna Bharati is a frustrated man. And his Bharati process of steel-making, which not only promises to help India tide over her steel shortage but produce an exportable surplus, is in the hands of a group of West German firms.

An Indian Expert Committee had found the Bharati process not feasible. In April this year, a West German firm, Demag, offered to buy the rights to use the process in underdeveloped countries — Africa, South America and Asia, excluding India and Japan. The deal was almost clinched, when the Germans had some afterthoughts. They wanted the world rights. Reluctant, Mr. Bharati sought the Prime Minister's help, but was told to go to the steel ministry again. Meanwhile, a few more German firms joined hands in mounting pressure on Mr. Bharati. While the steel ministry was still brooding over the matter, the Germans were ready with a " fabulous " offer. And when the ministry finally opened its gates, calling Mr. Bharati for fresh " talks ", the horse had already bolted. The German firms, it is learnt, are now offering the process to India on a turn-key basis.

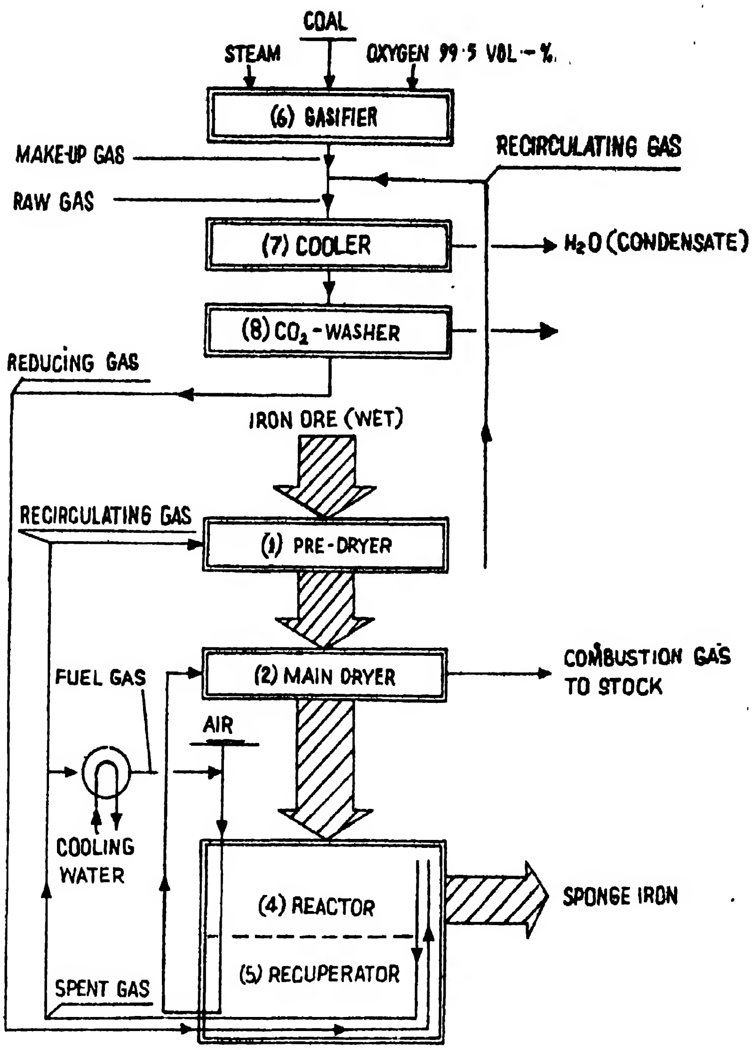
A million tonnes of steel at Rs. 80 a tonne. And without the use of coking coal and the cumbersome blast furnaces. That is what metallurgists have been dreaming of for years. Steel-making has for ages been based on the conventional blast furnaces, using metallurgical coal or coking coal to reduce iron ore (iron oxides) to pig iron. But in recent years, steel consumption has been shooting up, while the world's reserves of coking coal have been fast depleting. And despite advances in the blast furnace technology like a rise in output from 1,000 tonnes a day to 7,000 tonnes and a reduction in coke consumption from 1,000 kg to below 500 kg a tonne in Japan, metallurgists think that the blast furnace will soon outlive its optimum efficiency, both in size and productivity. Faced with such a prospect, major steel-producing countries like Japan have already entered into long-term agreements on the import of coking coal. According to one estimate, world steel production is expected to be 1,500 to 3,000 million tonnes by the end of this century. Even assuming a coke rate of 300 kg a tonne of pig iron, the coking coal needed for such a production is 600 to 900 million tonnes a year, about twice the present coke consumption.

THE problem is particularly acute in India. Poor quality coke with a high ash content has kept the productivity low at only 1,500 tonnes a day in our blast furnaces. With a high coke consumption of about 750 kg a tonne and with the commissioning of the Bokaro plant, our coke reserves may not last long. The Government is also thinking of importing coke from Australia. For India, therefore, the answer may be a steel-making process which does away with coking coal and also makes use of its abundant supply of poor quality coal.

BHARATI

The Bharati process does exactly this. The pig iron produced in the blast furnace has a high carbon content and also other impurities such as silicon, sulphur, phosphorus, etc which are reduced to the required levels in the converters to make steel. Besides, two-thirds of the coking coal used in the blast furnace operations goes to raise the temperature to the required degree (about 1,800°C) and only the rest is used for the actual reaction. In the Bharati process, the iron ore is reduced directly to sponge iron which is free of most of the impurities, and then converted into steel, adding carbon, etc according to the product needed.

Not that the idea is entirely new. Called the direct reduction process, several versions of the technique have been under trial for quite some time now. Some are, in fact, on commercial scale. But the problem here is of the scale of production. The maximum unit production reached so far by one such process (SL/RN) is 1,600 tonnes a day. The size and design (3,000 cubic metres per 1,600 tonne/day capacity in the SL/RN process) of the rotary kilns and the vertical shaft kilns used in these methods seriously inhibit any rise in the output.



Flow diagram of the Bharati process

THE Bharati process, on the other hand, has a production capacity of 3,000 tonnes a day, at a reduction chamber volume of only 550 cubic metres. What is essentially Mr. Bharati's invention here is the right proportion of the reduction gases, carbon monoxide and hydrogen, and the kiln design such that several kilns, made of steel with brick lining and with a volume of 50 cubic metres each, can be used in a series. The gases can be obtained from ordinary coal. And since the reaction is also exothermic (releasing more heat than it consumes), it heats the charge; the excess energy can be used to produce electricity. After an initial feasibility study, Koppers, a leading West German firm, estimated that a 1-million-tonne plant would need an investment of only Rs. 50 crores against the current Rs. 400 to Rs. 500 crores for the conventional process. A 1-million-tonne pilot plant would cost about Rs. 7 to 10 million.

The process itself was the result of long years of research. The idea occurred to Mr. Bharati back in 1934 when he had just started business after graduating in science from F.C. College, Lahore, where he was born. He had noticed that iron ore kept in cast iron saggers had been reduced to iron in a few days; the carbon in the cast iron had eliminated the oxygen in the iron ore. That gave the clue, and then followed a series of painstaking experiments till he found the right amount of the reductant gas mixture.

However, when, in 1960, Mr. Bharati asked top metallurgists in the country to consider his process, they were rather indifferent. While sponge iron was the direct reduction product, the authorities insisted that the production of "pig iron" by the Bharati process had nothing new in it. Two years later, Mr. Bharati sought help from the Hindustan Steel Ltd. And as the HSL was still undecided even after six years, Mr. Bharati entered into an agreement with Koppers on a feasibility study of the process. If found feasible, Koppers were to be associated with the commercial production anywhere in the world. Meanwhile, the HSL started experiments at the Durgapur plant, but Mr. Bharati stopped the experiments as the gas they used was not of the right quality. The HSL then insisted that Mr. Bharati should abrogate his agreement with Koppers if it were to take up the project. Mr. Bharati refused.

TALKS went on for some time. In 1971, the Government referred the project to a group of experts. The group accepted the concept as sound but rejected the process on the grounds that it would be difficult to push a heavy mass of sponge iron out of the reduction chamber and that any leakage of carbon monoxide, a poisonous gas, will be dangerous.

The committee also pointed out some other problems connected with the size of the iron ore pellets, gas generation, recirculation and recuperative systems. Requests by some Members of Parliament to reconsider the issue in view of its immense benefits and the German firms' interest in it were turned down by the Union Minister of Steel, Mr. Mohan Kumaramangalam, in May this year.

How serious are the problems pointed out by the Expert Committee? Though Koppers, who had found the process feasible, had themselves mentioned these hurdles, they had also admitted that these were essentially engineering and design problems and, therefore, could be overcome. They had even suggested certain alterations in the design. Many engineers in India too agree that the problems are minor and that the process deserved a more serious study. Maybe, a pilot plant tied with one of the coal-based fertiliser factories with enough reductant gas supplies would not have cost much. The mechanical problems could have been solved by bringing in a team of metallurgists and design engineers on the project.

The question here is more of our attitude to inventions and inventors. And it is not the first time that an inventor has been compelled to seek recognition elsewhere (see SCIENCE TODAY, p. 10, June 1972). Why is it that new processes should finally come to us through another country even when they originated here? While Koppers were willing to cooperate with Mr. Bharati in perfecting the design, the Indian Expert Committee was content in pointing out some problems and rejecting the process, though the idea was sound. According to Mr. Bharati, his requests to be consulted on the plan were rejected by the Committee. Is it official indifference? Or lack of courage to experiment? Or is it simply that the strong interests behind the blast furnace technology did not want their applecarts to be upset? For the investments in blast furnace plants are quite high. And the Bharati process seriously challenges the blast furnace technology.

letters

Fire & smoke detectors

IN the summary of my paper on fire-prevention in factories in the article "Fire! Fire!", May 1972, the author has omitted one important point. I had pleaded for the discontinuation, and if possible, a ban on the use of CTC (carbon tetrachloride) extinguishers. Experience has proven that CTC vapours are very toxic and invariably fatal. To protect factory workers and firemen this fact needs very wide publicity. We hope the Ministry of Home Affairs, Government of India, will act and ban the use of CTC.

The section on fire and smoke detectors should have been more elaborate. Early detection of fire has assumed great importance. Lives can be saved, and the fire easily extinguished before it reaches the "conflagration" stage. I give a few schematic diagrams (pp. 7 & 64), and the principles on which these detectors work, so that some entrepreneurs may attempt to manufacture them locally.

Heat detectors

1. Bimetallic detectors: Difference in expansion of two metals is used to detect heat. Figs. 1 (a) & 1 (b).
2. Air pressure detectors: Expansion of air due to heat is used to actuate the alarm. Figs. 2 (a) & 2 (b).
3. Thermistor: The change in ohmic resistance of electronic element is used to actuate alarms.
4. Infrared detectors: Infrared rays from the fire are detected and the fire alarm sounded. This is a very sensitive detector.

There are other detectors which detect a rapid rise in temperature. Sprinklers are fire detectors-cum-fire extinguishers.

Smoke detectors

Smoke detectors are particularly useful in air-conditioned buildings or in large godowns.

1. Ionisation detectors: A radioactive substance emitting α rays is used to ionise the air between two electrodes. Smoke particles getting in between the two electrodes reduce the current. Figs. 3 (a) & 3 (b).
2. Light-scattering system: Here the light from the bulb does not reach the photocell. When the smoke gets into the detector, the scattered light reaches the cell and the resulting current actuates the fire alarm. Figs. 4 (a) & 4 (b).
3. Light obscuration: Here the light falls constantly on the cell. Smoke obscures the light

(Contd. on page 64)

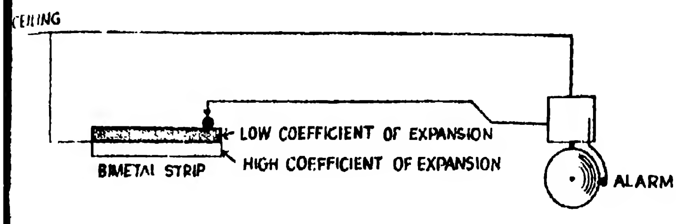


Fig. 1 (a)

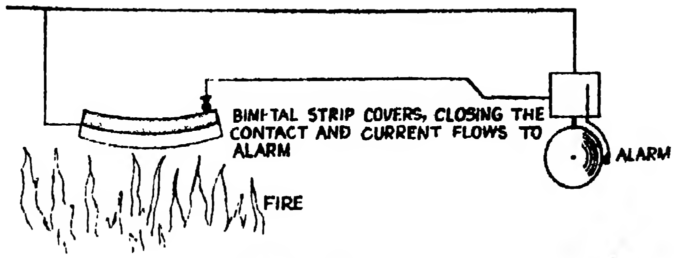


Fig. 1 (b)

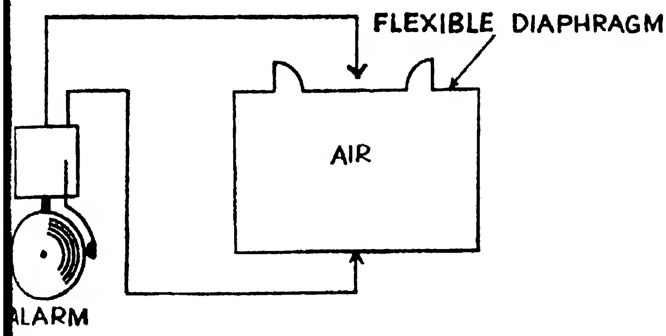


Fig. 2 (a)

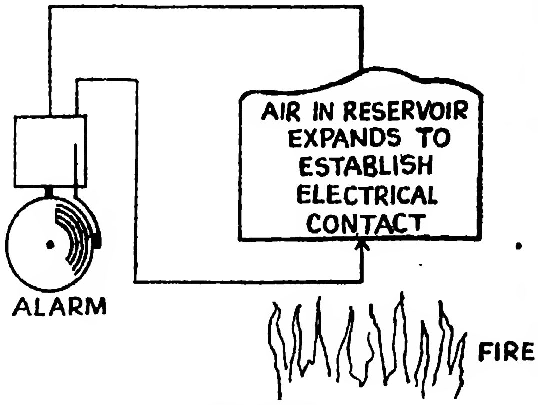


Fig. 2 (b)

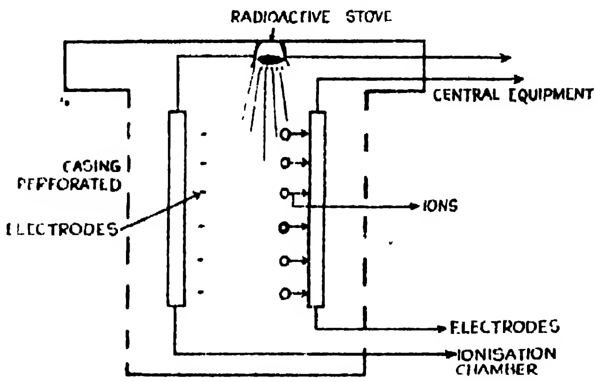


Fig. 3 (a)

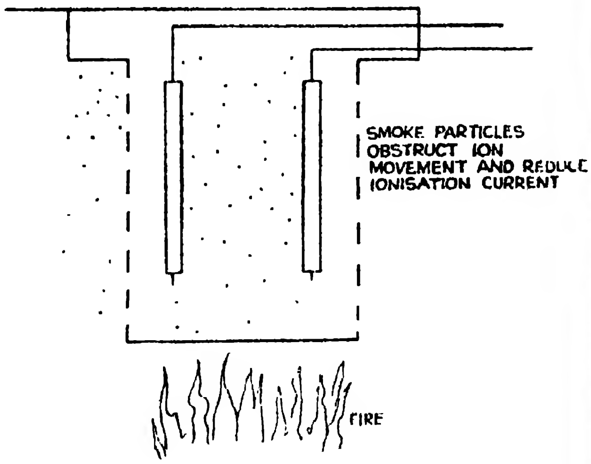
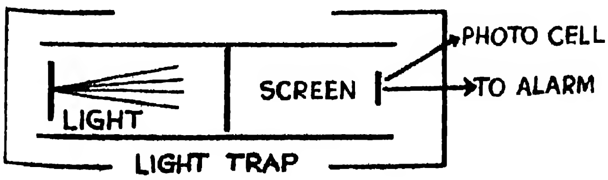


Fig. 3 (b)



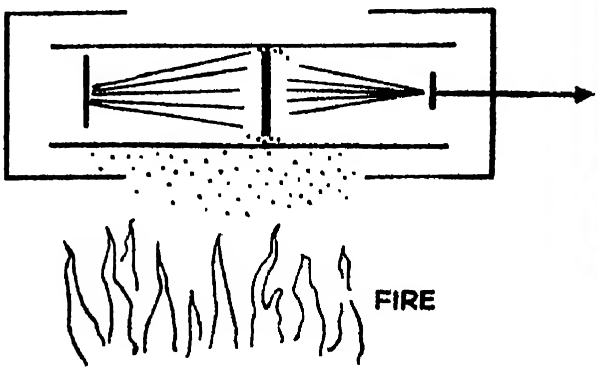


Fig. 4 (a) Right: Fig. 4 (b)

science shapes life

Towards clearer TV pictures

An American firm has developed a device called the Laser Beam Image Reproducer (LIBR) to produce superior TV films. In clarity, the picture having more than 20,000 lines of resolution, will be 40 times sharper than the current films. Equipped with a high resolution camera, the laser system is designed for earth resources satellite photographing missions. Long distance transmissions can be recorded on the film in just four seconds, which is a mere 1/20 of the time taken now. High resolution pictures can be reproduced from recorded video signals, film transparencies and camera films.

The helium-neon laser is controlled by electronic signals fed through an electro-optic light modulation system. The diameter of the modulated beam is then enlarged and focussed. It is then passed through a fast-rotating scanning mirror which deflects it on to a 24·1-cm wide screen in a finely focussed scan of less than .0005 cm. A series of adjacent scan lines are focussed on the vertically moving screen to give a clear picture of high geometric accuracy in a wide range of shades of grey.

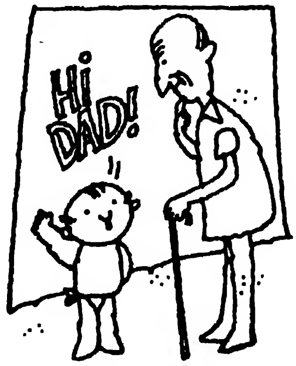
The urban carcinogen

The cigarette-loving country cousin is less prone to cancer than his urban counterpart. Even if a city smoker migrates to the country, he carries the permanent stamp of automobile exhaust gases. The main air pollutant connected with cancer is 3-4 benzpyrene from burning organic matter. However, air pollutant extracts free of this compound, when injected into mice, proved to be carcinogenic. The composition of this extract is not clear but it is known to contain di-alkylated benz (c) acridines which are products of fossil fuels

The smelly light

Monkeys knew about X-rays before Röentgen discovered them. They can see X-rays. They can even smell them. Röentgen and several others claimed that X-rays were visible as dull blue rays when projected in a dark room. In 1965, a book on behavioural responses claimed that monkeys could detect X-rays in a well-lit room by their smell. Further investigations carried out by Thomas Chaddock of Florida State University, USA, confirmed this. In his experiments, monkeys responded to X-rays in a well-lit room and pressed a lever for food. When their sense of smell was destroyed, they failed to do so. But these same animals responded again to X-rays in a darkened room. Blind-folded, they lost their unique ability again. By projecting X-rays along with many other radiations, it was shown that the monkeys saw the X-rays as a shade of blue.

To skip a generation



Much to the distress of some folks, children often turn to their grand parents. So why not widen the generation gap itself till it goes full circle?

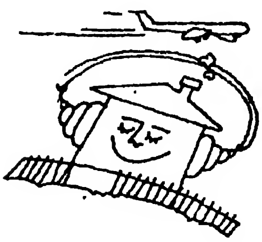
A firm in the US has started a unique banking system. It stores male germ cells for its clients to tide them over a rainy day — perhaps to continue their broken family line, or to protect the future children of the nuclear equipment worker from the hazardous radiations he has to face in day to day life.

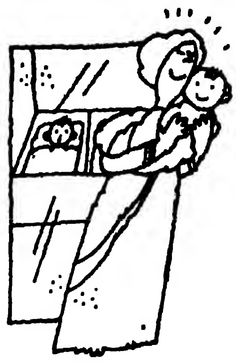
According to Jerome Gilbert, the vice-president of the firm, these cells are viable even after 10 years — so why not longer — two decades, three, or for a century or two.

The diluted ejaculate is phialled in 12 or 15 plastic containers with a glycerol preservative. These are stored in a metallic box which is chilled under liquid nitrogen. The most common clients of this bank are men who undergo vasectomy and fear they may have second thoughts later on. This bank also lends to sterile men who cannot have children of their own.

Soundproof tax

The new Tokyo international airport will have to pay compensation for the noise disturbance it creates for its neighbours. The governor of the district of Chiba, where the airport is situated, plans to levy an additional tax on aircrafts, and use part of the landing fees to soundproof the houses nearby. Domestic flights pay an extra fuel tax. Part of it could be used as a noise tax by the authorities.





Bringing up mother

Mothers can be permanently imprinted with special child care behaviour, says Marshal Klaus after studying the early interaction between mother and child and their subsequent behaviour. Klaus, a researcher at the Case Western Reserve University in the US, allowed mothers to be with their newborn babies for an hour within three hours of birth and for longer periods (extra five hours instead of just half an hour at feeding time) later on.

He found that such mothers were more attached to their babies. They fondled and soothed them more often than the control groups, and were more reluctant to leave the babies with other persons. Klaus suggests the existence of a maternal sensitive period during which a mother's attitude towards her child is determined. If the existence of such a period is established then the practices of maternity hospitals will have to follow a new pattern to bring up the mother.

Energy-making enzymes

Enzymes in the membrane of the mitochondria — thread-like bodies in the cytoplasm — burn up to give the living cell its energy. A biochemist Effraim Racker, of Cornell University, USA, isolated one of these enzyme systems from beef heart cells. He has succeeded in producing energy from food by mixing the enzymes with fat molecules.

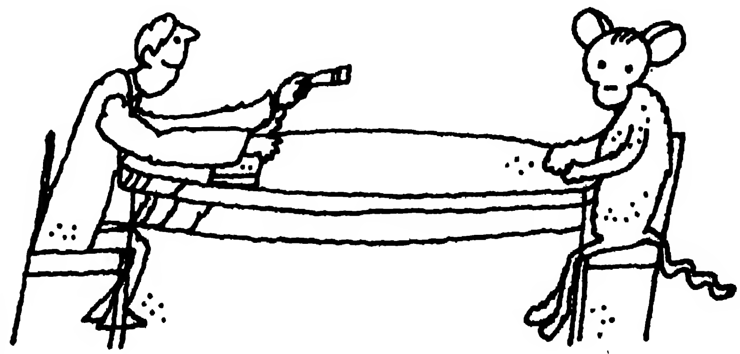
In normal animal cells most of the energy is produced by mitochondria, says Racker. The energy obtained from sugar fermentation is small. However, the major portion of the energy output in cancer cells is got by sugar fermentation. A clearer picture of how different cells produce energy may help in the development of methods to control cancer growth.

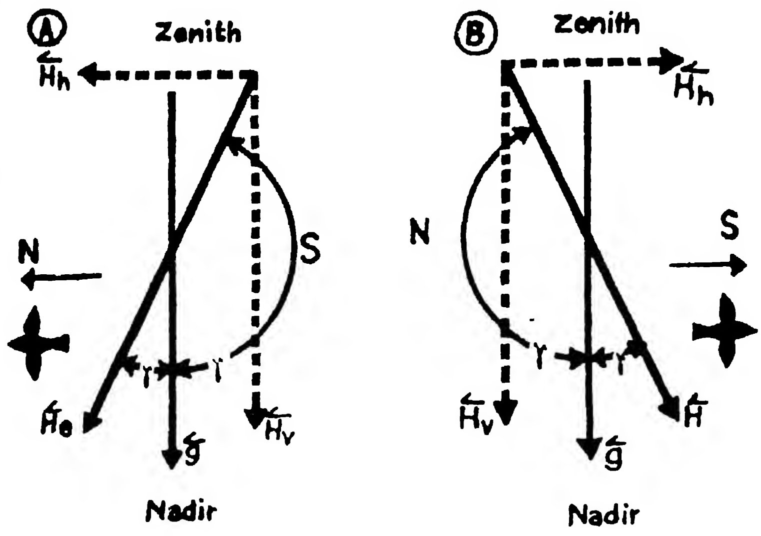
Man-ape summit

With Mr. Nixon trying to understand Mao, and Mrs. Gandhi condescending to confer with Bhutto, a scientist of Georgia State University, USA, Duane M. Rumbaugh, is now trying to communicate with the great apes.

Studying great apes at the Yerkes Regional Primate Center in Atlanta, USA, he concluded that they were superior to gibbons and monkeys. The comparative study of the cortical evolution and understanding skills showed that learning and transfer of learning skills were definitely correlated to it.

Applying this study, Rumbaugh will try to communicate with the chimpanzee and orangutan through symbols on a computerised keyboard.





A is the natural geomagnetic field at Frankfurt, and B is the artificially induced field

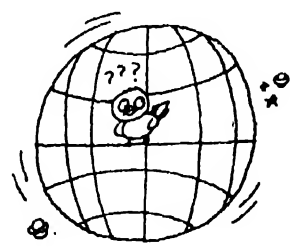
The robin's compass

The earth's magnetic poles are not static.

Birds are said to make use of the earth's magnetic field to find their way while migrating. In that case every half a million years their compass should turn through 180°. The European robin (*Erithacus rubecula*) seems to have overcome this problem, by navigating itself not by magnetic polarity but by the magnetic axis. This was shown by two West German zoologists who studied the robins in a state of migratory restlessness.

The birds were placed in a special octagonal cage with eight radially arranged perches. The cage itself was placed between huge Helmholtz coils by which the magnetic field around the birds could be changed. The pattern in which the birds settled on the perches was recorded by computer.

In the course of the study it was found that the polarity of the magnetic field did not affect the robins. Even when the polarity was reversed the birds kept their direction, but when zero axis was induced they felt lost. It is the inclination they take into account. Thus if a European robin were left along the equator where the axis is zero, it would not be able to find its way. Fortunately, its route does not cross the equator like those of the other migratory birds.



Blame his parents ...

It's all in the genes — the preference for alcohol. Dr. Liise Ahtee of the University of Helsinki, Finland, claims that genetic factors govern the preference for alcohol.

Prohibition may adversely affect the intellectual standard of some addicted people. It has been shown experimentally that alcohol-preferring rats have higher brain levels of 5-hydroxytryptamine (5HT) than water-preferring rats. Even forced dosages of 10 per cent alcohol to water-loving rats brought about no change in their brain level of 5HT. At the same time, alcohol-preferring rats treated similarly showed a 31 per cent increase in brain levels of 5HT.

... or make him sick

Alcoholism cannot be curbed by legislation. But *Science News* reports a new way to cure tipplers. Therapists have developed methods to teach a patient to feel sick at the thought of drink. The possibility of the patient pretending nausea is yet to be overcome. Ralph L. Elkins hopes to do so by verifying the physiological responses on a lie detector or polygraph. He checks them by comparing the changes in galvanic skin response, respiration and heart beat when the patient says he feels sick.

Population implosion

Human population may not explode after all, if the behaviour of mice is any indication. Overcrowding makes mice murderous. Man being human may be more gentle. Perhaps nature will take over. Changes in the social structure like the women's lib movement, free sex and contraceptives are leaving their mark on men — the partners of sexually free women are upset people. Four cases have been reported of men becoming impotent when confronted by sex-hungry women. The researchers conclude that this is more an adaptational and social framework than a psychological phenomenon.

Crumbling papers

Jack Anderson may expose himself out of business if the White House decides to switch over to self-destroying paper.

A certain British magazine has allegedly brought out its recent issues on such paper — perhaps in the interest of its publicity or may be in public interest.

This paper contains numerous spores of a fungus which thrives on cellulose. Its enzymes reduce paper into a fine white powder. But beware! Such paper contaminates any other paper it comes into contact with.

Sing your weeds away

Dry seeds do not respond to sound. But wet seeds may dance to your tune. Scientists at the University of North Carolina, USA, have found that wet turnip seeds exposed to certain frequencies begin to germinate 100 per cent faster than usual. They are hopeful of applying this technique selectively to weed seeds. If successful, weeds could be induced to germinate faster. They could then be got rid of without the use of stable chemicals that usually stay on to pollute the environment.

Pinpricks to relieve pain

The Chinese scientists at Shanghai are developing a method to use acupuncture for anaesthetising. Nobel laureate Dr. George Wald doubts the efficacy of acupuncture as an anaesthetic, but says it may act well as pain-reliever. Acupuncture needles constantly stimulate the major nerves thereby decreasing the sensitivity of the smaller ones which carry pain stimuli from their free endings.

Looking at the brain in slices

Taking a brain X-ray used to mean hospitalisation and prior treatments involving injecting X-ray opaque dyes, radio isotope tracers or air. All these are lengthy procedures and tire the patient. However, they will soon be replaced by a quicker and more efficient method.

The Electronic and Industrial Operations Division of a British firm in Middlesex has made a diagnostic machine which looks at the brain in slices. The patient lies on his back with his head in a hole in the machine. A 1-cm thick X-ray beam is passed through the brain and the machine rotates around the patient's head taking 56,000 readings in one scan. The varying intensities of the emerging rays are measured by a detector linked to a photomultiplier. A mini computer correlates the intensities of rays from the different paths and produces a numerical figure on a cathode ray tube display. The brain is scanned two slices at a time after which the machine automatically slips to the next pair. About four minutes are necessary to examine each pair. The complete examination is covered in six to eight slices. On an average, four patients can be dealt with in an hour. This makes the machine practical for outpatient use.

Even minute tumours which may be missed by other methods are detected. Different types of tissues are clearly distinguishable. This technique, when applied to other parts of the body, will help to detect cancers still in the early stages, when it can be cured by surgery. Finally, the X-ray dose is very much lesser than in the normal X-ray examination method.

IS THIS MARTYRDOM

It must never be, not even to prove a point. The suicide note had indicted the apathy in IARI's administration; in effect, it spelt the virus that infects the whole of Indian science today. Diagnosis will be a hard task, cure may be harder still.

NECESSARY?

Dr. Bhattacharya's analysis will be a hopeful beginning if it provokes some rethinking, some debate out of the mire of indifference

K. R. BHATTACHARYA

FOURTH May, nineteen hundred and seventy-two. Dr. Vinod C. Shah, a research scientist at the Indian Agricultural Research Institute, committed suicide. It was like the reenactment of a scene 12 years ago. In early January 1960, Dr. M. T. Joseph, another IARI scientist, had opted for the same way out. It was the same story of extreme frustration. Dr. Joseph, if I remember correctly, had already spent some 15 years at the IARI. He had joined the Institute after his BSc. It was while working there he took his MSc and a PhD. He went abroad for further study. He came back — to his job as Junior Scientific Assistant — the lowest rung in the ladder from which he was never allowed to climb up. (His salary was a mere Rs. 150 per month.) He had applied for better jobs, but his applications were not forwarded. The Haffkine Institute offered him an appointment twice, but he was not released in time. At last, Dr. Joseph took the hardest way out.

Dr. Joseph's death had created a storm in the country. It was calmed bit by bit with Mr. Nehru's expression of "distress", Mr. Tayabji's inquiry, promise of "changing the rules", and Mr. Patil's persuasive skill and munificence.

Slowly life returned to normal in India's science. The defensive postures gave way to cautious official optimism. Following the border clashes with China in October 1962, and still more so after the fight with Pakistan in September 1965, official pronouncements laid ever greater stress on science for "defence and development". The outlay for research increased. From the end of 1962, vast changes were brought about in the Council of Scientific & Industrial Research (CSIR). Calls went forth for "democratisation" and "abolition of hierarchy" in Indian science. And, in 1966, when the Indian Council of Agricultural Research (ICAR) was set up as an autonomous body, there were visions of prosperity outside Government's red tape.

Meanwhile there were other developments. Foreign money poured into the country. Science too happened to be at the receiving end, particularly agricultural (and social) science, and research boomed (with unprecedented opportunities of career advancement, expert assignments, foreign trips and other prequisites). Meanwhile too in the mid-sixties, the "miracle seeds" were scattered in ICAR (and mushrooming agricultural universities) by munificent foundations which quickly sprouted; the IARI was hailed as the great harbinger of the "green revolution". And, in 1971, with the setting up of the Ministry of Science and Technology, great changes in CSIR, the Sarkar Committee report, and setting up of the National Committee on Science and Technology, buoyancy seemed to reach a new high, heralding the "arrival" of science in free India.

Beyond the festooned arch, however, the shadows lingered. The inner ferment continued — for any one with eyes, and willing to use them, to see. Sharp eruptions occurred at regular intervals. The setting up of the ICAR itself was accompanied with prolonged turmoil among its employees, but this was quietly ignored. (This had nothing to do with science, though. The unrest was mainly due to the changes in service conditions that the change-over created. The employees were not consulted, nor were their protests heard. The point here is that of grinding bureaucracy.)

The phenomenon of "brain drain" attracted periodic attention, but was slurred over in vague talks and analyses. Then came the Great Controversy over CSIR in 1968 with all its ugly overtones. It took three years' patient work, a committee and a change of the CSIR chief to sweep the dust under the carpet.

And recently, in July 1971, an attempt was made by some IARI scientists to question the truthfulness of certain image-building claims — a basic right of all scientists. But this hardly raised a ripple as it was quickly mowed down by the unabashed use of power and the carrot.

The incident is worth a recall. The IARI Branch of the Association of Scientific Workers

DR. K. R. BHATTACHARYA, President of the CSIR Scientific Workers' Association (of which he was the Secretary last year) is a scientist with the Central Food Technological Research Institute, Mysore. An M Sc from Calcutta University, he worked from 1955 to 1960 at the Indian Institute of Biochemistry and Experimental Medicine in Calcutta. Since 1960 he has been with the CFTRI. He took his Doctorate from the Calcutta University in 1963. Besides his scientific work on rice processing and technology, he has been actively working towards bettering the Indian scientists' lot for quite some time.

of India brought out a bulletin called *Young Scientist* in July 1971. (The issue was dated June 1971 and was the first and the last.) In an open challenge — " Agricultural Research: Claims versus Realities " — the following points were made: (*i*) Scientific claims should be discussed in scientific journals and forums, and not over publicity media; (*ii*) Some of the claims of success made by the IARI were tenuous. For example, it was claimed, Opaque II, a new maize discovery, had a high protein content. The article said Opaque II was not an IARI discovery, nor was its protein content beyond doubt; (*iii*) Many of the new rice strains released in the country were not the best of the available lot, but had been released to humour the " prestige " of certain people at the top, e g the Sabarmati variety; (*iv*) IARI scientists claimed to have 'discovered' Sharbati Sonora, a mutant wheat variety, whose protein and lysine contents were said to be many times that of the normal variety. But the report of the International Maize and Wheat Improvement Centre in Mexico (*CIMMYT News*, July-Aug 1969) questioned the validity of this claim.

The article was unsigned. Soon the IARI clamped down on the Association with full administrative pressure. Official memos were addressed to each member of the journal's editorial board in the form of a printed declaration to be filled in by him stating whether he was/was not responsible for the authorship of the said article. Most backed out and the protest as well as *Young Scientist* floundered.

Now Dr. Vinod Shah, by hanging himself to death " so that other scientists can get a proper treatment ", has finally shattered the official picture of serenity and confidence and brought the scene back to where it was 12 years ago.

II

AS in the case of Dr. Joseph, so also now, attempts are being made to shake off the unexpected consternation by bringing in extraneous issues. Did Dr. Shah have any " justifiable " reason to complain? Was there any " irregularity " in the particular selection? One fails to understand why, when the rules themselves provide all the opportunities to do what one likes, one should be so foolish as to commit " irregularities ". The perennial debate on the method of recruitment and promotion has been revived. Shall it be the UPSC tweeddledum or the departmental tweeddledee? A seminar has been just held in New Delhi on this question (which like many such discussions held by eminent people in the past failed even to understand the central point of the matter, viz the stupidity of promotion through advertisement, as has been pointed out by us many a time). An inquiry to go into the matter referred to by Dr. Shah in his letter and the rules for recruitment and promotion has been instituted. But an inquiry into the total affairs of the Institute — the least that was called for under the circumstances — has been stoutly resisted.

At the same time, doubts have been cast on the " justification " of Dr. Shah's action and his expressed sentiments. In his letter written at the time of his death, Dr. Shah mentioned about the various malpractices prevailing in the Institute, including feeding the director with manipulated data to suit his line of thinking, no doubt for personal advantage. Finally, he said, he decided that the time had come when someone should sacrifice his life so that others could have a better deal. We honour this sentiment of Vinod Shah, for no man on the verge of death indulges either in bravado or in hypocrisy. He proved his convictions by giving his life, more than which no man can give. We salute his sentiments and we pay our deepest tribute to his spirit of sacrifice for others' benefit.

BUT how are we to vindicate his martyrdom? What does it signify? An inquiry, far wider in its scope than the one now instituted is no doubt called for, for which pressure should be exerted on the Government by all concerned. But is that enough? Is the matter such that it can be tackled by a mere legalo-technocratic tinkering?

M. T. Joseph's was indeed a heart-rending story, where death alone was probably the only escape. But Vinod Shah's case is on a different footing. He was certainly on what

may be called the higher rung, and he was young. This is perhaps the most poignant, the most crucial aspect of the tragedy, for it shows *frustration in India's science establishments has no line of demarcation. None is immune to it.*

Why does it happen? To understand this will need an analysis of the background to our science.

III

SCIENCE is not an autonomous entity but is intimately linked with the social and economic activities of the people of the time. In history, science arose precisely out of such activities, out of change and need for change in the system of production and distribution, with which it constantly interacted.

But science, at least modern science, did not arise in this way in India. In fact, the traditional crafts and economic activities, which might have given birth to science in favourable circumstances, were destroyed by imperialism. Modern science then came here as a transplant from the West and grew in isolation from the surrounding environment merely as a means of colonial exploitation.

Unfortunately, the same enclave and transplant nature of science continues to this day. This is the key to all the problems of science and scientists in India. As J. D. Bernal said "where science has been kept a mystery in the hands of a selected few, it is inevitably linked with the interests of the ruling classes and is cut off from the understanding and inspiration that arise from the needs and capacities of the people" (*Science in History*, A. Watts & Co, London, 3rd ed, 1965).

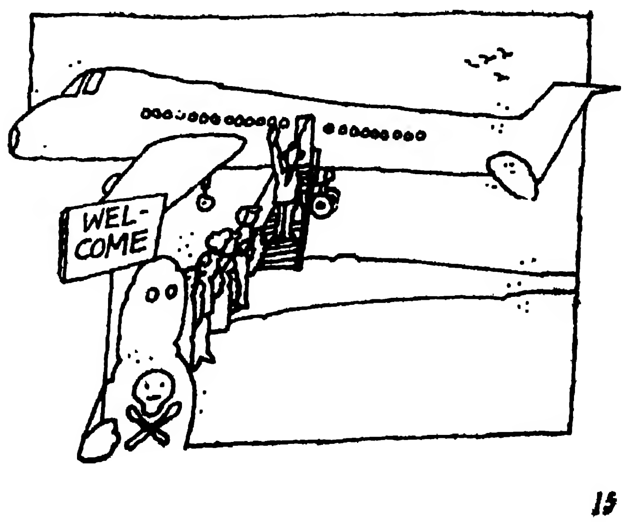
THERE are two facets of this isolation of our science from society.

One is the obvious divorce of our research from the life-stream and the economic activity of the vast millions of our people. This is partly shown by the language in which science is taught and practised in the country, which is alien to probably 95 per cent of our people. Again, the reality of our society is such that problems cry out for attention of science. Rural reconstruction, a thousand and one rural activities, fullest utilisation and improvement of traditional crafts and skills of people, simple production activities — all call out for immense involvement of science. Such involvement would not only benefit the people but would also lead to a flowering of indigenous science.

But these are matters not fashionable enough for the elitist science to be concerned with. Science, in this country, still remains confined to areas which are pure and 'respectable', and the common man looks upon it either as something vague, mystical and awesome, or as something parasitical.

The second is the isolation of our research from industry for which it ostensively works. This is due to the stranglehold of foreign companies on our industry (which is a part of foreign domination on our economy, discussed below). Our large-scale industry is directly or indirectly controlled by foreign interests — some by direct financial control, and the rest by collaboration. This includes the state enterprises. The technology is foreign and so also are the engineering means of production. And the methods are legion by which this hold of foreign collaboration, foreign technology and foreign machinery is sustained and multiplied. The small-scale industries no doubt rely largely on indigenous efforts. But these exist partly at the sufferance of the large industries as their ancillary units; partly, they are under constant pressure to "modernise" for "export" with the blessings of foreign collaboration.

Indigenous research has no role to play in this process of industrialisation and is starved of utilisation (see K. R. Bhattacharya, "Science politicking", *Seminar*, No. 148, December 1971). Indeed it is deliberately kept at a distance by many devious means including "expert" advice of interested lobbies, such as the Mafatlal Committee Report and the NCAER study. (The Mafatlal Committee Report went all the way out to propose liberalisation of import of technology from outside.)



In the wake of "Young Scientist"

Copy of the " Most Immediate/Out at once " Circular No. 4-26/71, dated 13/14th July 1971 issued by the Director, IARI to All Heads of the Division (by name), Project Directors (by name), Project Coordinators, all the office-bearers listed in the circular, and Dr. Y. V. Kathavate through the Head of the Agricultural Physics Divn:

My attention has been drawn to an unsigned article casting aspersions on some of the research work under way at this Institute in a publication entitled *YOUNG SCIENTIST*. The following staff members of the Institute are stated to be responsible for this publication in the first page of the pamphlet.

President: M. G. Ramdas Menon. *Vice-Presidents:* D. Srinivasachar, Y. R. Ahuja. *Secretary:* Y. V. Kathavate. *Jt. Secretary:* T. S. Raman. *Treasurer:* S. K. Prasad.

Editorial Committee

Radheylal, K. N. Singh, Jagdish Seth, J. G. Bhowal, P. C. Pande, Abhiswar Sen, R. P. Grover, D. L. Deb, T. P. Singh, T. V. Ramachandran Nair.

An all-Institute Staff Meeting will be held at 3·00 P.M. on Saturday, July 17th, in the Auditorium to discuss the issue raised in this article and to evolve suitable procedures for dealing with such problems. I am requesting the members of the Editorial Board of this Journal to be present and to explain their viewpoints. *All scientific* staff are cordially invited.

Copy of the ' most immediate ' Letter No. 4-26/70-RG (Pt. II) dated 28th/29th July 1971 issued by Shri A. K. Sharma, Member-Secy. of the Committee constituted by the Director, IARI, to Dr. C. Dakshinamurti, Head, Agri. Phys. Divn., and to Dr. Kathavate through him:

As per Officer Order No. 4-26/70-RG (Pt. II) dated 22nd July 1971, a Committee has been constituted for suggesting rules and guidelines for giving publicity to views about scientific matters. Director has desired that the views of the authors of the unsigned article entitled " Agricultural Research—Claims *Vs.* Realities ", appearing in the first issue of *Young Scientist* should be taken into consideration. In this connection, several scientists mentioned by Dr. Kathavate as being responsible for preparing the article have disclaimed all knowledge about it. I shall, therefore, be grateful if you would kindly get replies to the enclosed questionnaire from the following staff members of your Division and send it to me by 3-8-71.

Copy of enclosed questionnaire:

To Dr. A. K. Sharma, the Member Secretary, Committee to suggest rules and guidelines for giving publicity to views about scientific matters.

Through: The Head of the Division of ....

Sir,

I agree with the statement of Dr. Kathavate that I am responsible along with others for preparing the unsigned article " Agricultural Research — Claims versus Realities ".

OR

2. I was not concerned in any way with the preparation of the article in question.

Yours faithfully

....

N.B. Please strike out whatever is not applicable.

IT is true that agricultural research comes on a slightly different footing than the general scientific research discussed above. The area of its utilisation is not completely monopolised by foreign technology, nor is it completely divorced from the life-stream of the people. However, the difference is only in degree and not in essence.

For instance, the utilisation of high-yielding technology is directly linked with the use of chemical fertilisers, pesticides, and mechanised equipment. These are mostly under the direct or indirect control of foreign monopolies. Not only that. The use of high-yielding agricultural technology has led to a sharp concentration of wealth in the hands of prosperous landed interest and destitution of the small peasant and the landless labour.

This is how the paradox works. The more you modernise your technology, the more inputs you are called upon to provide. That becomes a privilege of those who have money or can raise it through credits and loans. (Despite the socialised aims of lending through banks, how many poor farmers have in fact benefited?) Technology brings in mechanisation. The farm labourers and the share-croppers are displaced. The other not-so-happy feedback of the Green Revolution is that the introduction of new seeds and new cropping method affect the ecology. Pests multiply; without pesticides, the crop is ruined. Hence the poor farmer ultimately has no choice but to yield his land to the wealthier man. Another less known fact is that whatever benefits the Green Revolution may have brought about,

they remain confined to irrigated areas only. The choice for the nonirrigated areas — dry farming — is still just a cry. There is a mass of data on this entire aspect, not the least of which is a study conducted by the Home Ministry of the Government of India itself. (See a review of this and other literature in P. C. Joshi's articles in *Seminar*, No. 129, May 1970 and No. 137, January 1971.)

IV

UNFORTUNATELY, what I have shown is not an isolated picture of science but is rooted in the underlying socio-economic reality. That reality, to put it briefly, is the division of the society into a thin top stratum of the "ruling oligarchy" (to use the phraseology of Gunnar Myrdal — *The Challenge of World Poverty*, Penguin Press, 1970) and a vast lower stratum of the toiling masses, and the orientation of all social activities and institutions into a means of appropriation of social benefits by the former at the expense of the latter.

At one side of this picture is what has been called neo-colonialism — which is continuation of economic exploitation by developed countries by subtle means after the grant of political independence. This is reflected in the confinement of much of the industrial activity, as before independence, to mobilisation and shipment of primary commodities to the developed countries at nominal cost (mining, exploring, partial processing, transport, plantation goods); in sizable financial investment in the industry, in virtual control of the technology and production machineries of the entire large-scale industry; in orienting much of the industrial activity into production of sophisticated consumer goods having no relation to the needs of the country (toothpastes, cars, room-coolers, television sets, synthetic fibres); and in overall control of the economy through the concept of aid, export, and modernisation (see for example "The giver takes all", SCIENCE TODAY, p. 29, April 1972). Then comes the local large-scale industry which voluntarily collaborates with the external forces for self-benefit. A case in point is the modernisation of the leather industry (box right). The important point in this context is that the study and the tour of the industrialists was sponsored by the Government of India in cooperation with USAID and UNDP. The

"When you send your paper for publication, don't forget to add my name as senior author."

Import of technology.

"Foreign collaboration has been sought to manufacture and market leather products by a representative sales team of India's leather industry which has prospected annual exports worth over Rs. 3 crores in Europe, the US and Japan.

"The sales-cum-market orientation tour of these and some other countries was sponsored by the Government of India in cooperation with the USAID and UNDP. The team has secured export orders worth Rs. 40 lakhs and initiated joint collaboration agreements with as many as 11 firms abroad. Seventeen other firms have been identified for appointment as agents in various countries. The products include leather garments, footwear and components and finished leathers....

"It has been suggested that export duty on crust leather may be withdrawn and air-freight subsidy be given. Import licence for essential dyes and chemicals should be ensured to meet large export requirements. Import of certain essential items, which are banned or restricted under the present policy, may be allowed to meet specialised requirements of foreign buyers of finished leathers. Licences should also be promptly issued for import of sophisticated machinery to help modernise leather plants and streamline production to suit exacting requirements of foreign buyers both in quantity and quality.

"Import of machinery required for the manufacture of leather garments, wallets, shoulder bags and travel goods should also be permitted.... Cash subsidy amounting to 30 to 40 per cent may also be considered...."

(Extracts from a report in *The Hindu*, 26 July 1971)

US Influence on Farm Research?

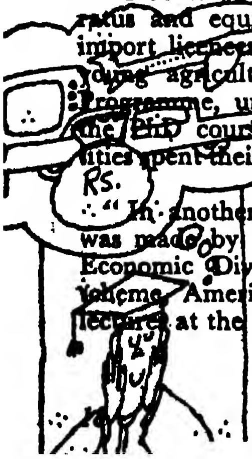
How free is scientific research in India? Does foreign influence operate under several guises both inside and outside our various institutions? A recent issue of the weekly news-magazine Link (14 *May* 1972) *has published several such instances of malpractices in the IARI. We quote from the magazine:*

"After the IARI was taken over from the Government and made into an autonomous organisation, according to many scientists, 'the increasing involvement of foreigners in policy-making, administration and academic matters' has caused serious misgivings.

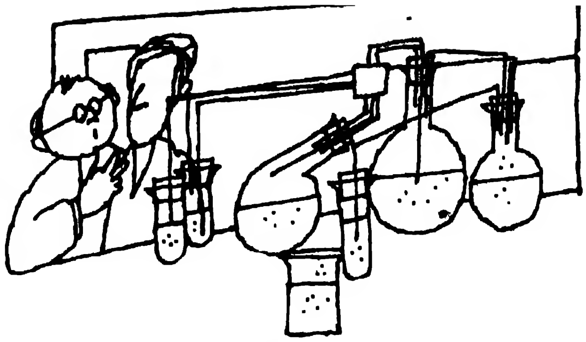
"A pamphlet published by the IARI branch of the Association of Scientific Workers of India discloses that foreigners not only sit on the selection committee but act as 'chairmen'. For a 'key post' at the IARI, it is said a foreigner, who long since had left India after working as the representative of an 'aid-giving' organisation, was made a member of the selection board and was present at every interview held for the post.

"Another example of foreign influence is an advertisement of posts in some agricultural universities inviting applications 'preferably from candidates with doctorate degree from the USA'. In view of this, 'highly qualified agricultural scientists having doctorate degrees from the Soviet Union found it difficult to get such jobs', it is said. It is learnt that there is not a single scientist with training from the Soviet Union in the Institute, barring one who has had to accept a job as a translator. . . .

"In a letter written to the Prime Minister's secretariat, prominent MPs pointed out . . . that the Americans have 'completely corrupted' many IARI scientists by inviting them to visit the US, and by supplying cars, jeeps and other vehicles for the use of the Director and other officials. IARI scientists have been known to 'freely ask the Rockefeller Foundation for supply of apparatus and equipment which otherwise require import licences'. Another factor corrupting the young agricultural scientists was the US Aid Programme, under which students admitted to the PhD course in Indian agricultural universities spent their first year in a US university. . . .



"In another case, a grant of 48,000 dollars was made by an American organisation to the Economic Division of the IARI. Under this scheme, American experts delivered a series of lectures at the IARI. . . ."



"No, you can't invent this. We are supposed to get it from the Americans."

tour team had entered into collaboration agreement with 11 countries. What is the need of the modernisation? Whom will the export and foreign exchange benefit? How much money will go for collaboration, for import of machineries and raw materials, for subsidy and import and export relaxations? Finally, if at all considered essential, could not this modernisation be done through the efforts of Central Leather Research Institute? Finally come various privileged groups (landed interests, administrators, professionals, the educated) who get some benefit and knowingly or unknowingly support the above forces.

All social institutions and social activities then become a means of maintaining the advantages of the privileged groups. Such for instance are the functions of education, administration, health service, press, industry, community development, new agricultural technology, and science. All are claimed and presented with the ostensible purpose of bringing benefit to the vast dispossessed masses. But all are in actual operation distorted and oriented precisely to serve the opposite end.

Science too must conform to this basic reality. It then adapts itself into one of three forms: (*i*) an elite activity divorced from the people, which does not interfere with the socio-economic reality. Take, for instance, the research carried out in many laboratories of this country. Maybe some important contributions are made by brilliant scientists, but, by and large, these have no relevance to the realities of the lives of the masses; (*ii*) a means of distributing some benefits to representatives of the privileged groups. The ruling class, as we have said, includes the educated class. Laboratories must be built, research institutions set up to accommodate the children of this educated class — to provide jobs for our young scientists; and (*iii*) enlisting what little it can

"Slanted Research?"
—Dr. Swaminathan's reply

IN *its* 11 *May issue, the* Times of India *carried an editorial "Slanted Research" on the points of exaggerated claims made by the ICAR as mentioned in Dr. Vinod Shah's suicide note. The editorial called the ICAR's relay-cropping technique and experiments with* baisakhi moong *total failures. The following reply from Dr. M. S. Swaminathan, Director of IARI, appeared in the* Times *on* 26 *May:*

Sir:—I will be failing in my duty to the late Dr. Sher Singh Bains who died a year ago and to the numerous young agronomists concerned, if I do not draw attention to the following factual data having a bearing on your editorial "Slanted Research"? In 1966, the late Dr. Bains started the relay cropping experiments in IARI and all the facts collected since then are to be published in a book which will be available towards the end of this month. The basic objectives of these experiments are: to increase the economic yield per unit of area, time and water, to improve crop productivity without detriment to the long-term production potential of the soil, and to establish a wide range of cropping sequences from which a farmer can choose the rotation which best suits his input purchasing capacity, irrigation source, seasonal conditions and marketing possibilities.

Ours is a sub-continent with a wide range of agro-ecological conditions. No cropping sequence can be appropriate at all places. The basic principle is, however, applicable everywhere except in the Himalayan region, ie the availability of adequate sunlight throughout the year provides a unique strength to tropical and sub-tropic agriculture by rendering the cultivation of more than one crop per year possible.

The remarks about potato and *baisakhi moong* are both incorrect. Experiments on the size of seed tuber are basic to the development of agronomic practices. Potato varieties like *kufri alankar* and *kufri chamatkar* have given at 49 locations during 1970-71 yields ranging from a mean of 170 to a maximum of 460 quintals per hectare in multiple cropping sequences. Similarly, at 78 locations in the national demonstrations, *baisakhi moong* has given yields ranging from a mean of 6·5 to a maximum of 17·0 quintals per hectare in about 60 days. The most important role of *baisakhi moong* has been not merely its good performance but in introducing the concept of all-season cultivation of pulses. Over 2,500 quintals of seeds of this variety were distributed by the state farms corporation alone last year.

Finally, may I say that the present structure of an agricultural research organisation provides for two crucial checks on the results of research workers, which explains why the recommendations made by agricultural scientists in all-India workshops (for example, the recommendations made in 1964 that only dwarf wheats could spearhead an upsurge in wheat production) have been proved to be correct in farmers' fields and in national crop production trends. First, every worthwhile result (whether relating to crop variety, timing of irrigation or fertiliser application) is checked in a national grid of coordinated experiments conducted by numerous scientists belonging to different disciplines and institutions. Secondly, every worthwhile finding is tested in over 1,500 national demonstrations in farmers' fields all over the country and those results which prove economical under a given set of conditions alone are likely to be picked up by the farmer. Currently in the case of rice, nearly 70,000 mini-kit trials are being organised in farmers' fields to ascertain their reactions to new varieties. The slant to research is thus only in the direction of developing farm technology which can lead to agrarian prosperity.

M. S. Swaminathan
New Delhi, May 11. *Director, IARI.*

do to reinforce the process of appropriation. To the third category belong many research programmes and projects, envisaged in the name of modernisation or benefit to the poor, which later help the economic vested interests to obtain licence or foreign collaboration. (Another case in point — the rice mill modernisation programme. Around the mid-sixties, a research programme was initiated to study the problem by the Ford Foundation, the Government of India and the Central Food Technological Research Institute at Mysore. Irrespective of the importance or otherwise of the study and of the benefits of modern rice mills, this programme finally facilitated the import of foreign technology which could

easily have been developed in this country in a very short time.)

MEANWHILE this science nurtures its own culture, particularly among the scientists, which again is in conformity with the prevailing culture of alienation, consumerism, elitism and self-seeking. Denied any true social goal, research institutions are themselves distorted and corrupted to breed inefficiency and malpractice, and become a training school for self-seeking from the highest to the lowest. They become not only enclaves, but breeding grounds of social evils.

[" The first point to understand is the relationship between the objective and functioning of an organisation, which can be best explained with the help of a somewhat rustic example. Suppose we have a Malaria Eradication Task Force. Now, if its declared objective is a true one, i e if the sponsors expect the Force to really eradicate malaria and would hold it accountable if it did not, then the Task Force, irrespective of any deficiency that it may initially have in its personnel or structure or methodology of functioning, will so orient these during its functioning as to render them ideally suited to achieving its aim. If on the other hand the declared objective is not a serious one, i e if the sponsors would as well accept some budget expenditures and pompous reports in its place, then the Force, even if it has a most ideal structure and management methodology to start with, will so adapt these during its functioning as not only to fail to eradicate malaria but to attain maximum individual self-interest for its participants (of course graded according to their hierarchical position).

" This then is the basic first hypothesis, viz that public sector science in India does not have a genuine objective and therefore the structure and management situation within these institutions is naturally oriented towards achieving maximum individual self-interest. It should be noted here that a laboratory belonging to a private industry would have a clearly defined objective, viz the maximisation of profit of the company. If the company is efficient, and if it really needs research (rather than just for prestige), the laboratory would surely so orient its structure and functioning as to achieve that objective. Therefore, the possible efficient functioning of a few stray laboratories of this kind, if any, does not in any way disprove the above proposition. Whether the efficient functioning of these private laboratories serves any real interest of the Indian people, however, is a different matter." (" Science Politicking ", by K. R. Bhattacharya, *Seminar*, December, 1971.)]

" Not much scope for research, I agree, but think of the benefits — air-conditioned cabin, two secretaries and you get invited to the embassy cocktails . . . "

Scientists in these institutions are brought up in a value system of pomp, status and pursuit of self. They have no other goal before them except self-benefit for which nearly all means are fair, including manipulation of men, material and research data (as hinted by Dr. Shah). Scientists from the highest to the lowest enter into a rat race, where the sky is the only limit.

In such a setting, therefore, the scientists are caught in a trap from which they cannot escape. Frustration becomes their inevitable companion. Hence the seething discontent, the constant complaints and unending grievance of all scientists in the research institutions. If one side of this frustration is the pervasive corruption and manipulation inevitably present in all spheres and at all levels in the laboratories, the other side is the near-complete degradation of the value system of all concerned into a blind race for greater and greater advantage. (As a corollary, the collapse of a value system brings on the withering away of courage, e g the backing-out of the *Young Scientist* authors.)

There is only one way out from this trap — to inject some purpose and objective in our science. This requires two steps: first, to extricate the country from foreign control, and second, to integrate science with the lives, the activities and the needs of the people. Only by leaving the temples and coming to the people will science find its natural habitat. Once science and scientists have a definite social goal, both corruption and the blighting values will disappear from the laboratories and only then will frustration become a thing of the past. Our people too will benefit.

It is such a reorientation in India's science that we scientific workers should work for — as much for our own sake as for that of society. This is the lesson of Vinod Shah's martyrdom.

Want to stop the killer floods of our northern rivers ?

Want to keep the Bhakra region well stocked with water ?

Start tinkering with the icy wastes of the world's highest mountains. This is not wishful thinking ; it can be done

The Himalayan Glaciers

JAGDISH BAHADUR

IT happens every year. The rivers swell, the land is flooded and crores of rupees worth in men and material are washed away. One year it is the Gomati. Another year it is the Gandak. May be the Jamuna. Or the Alakananda. Remember the devastations of July 1970 ? Some studies carried out in the past few years have shown that 60 per cent of the flood damage in India has occurred in the regions covered by the Himalayan rivers. And the culprit are the glaciers. The same year, 1970, the Bhakra region went short of water, although that year the rainfall had been above the normal. The reason ? Poor melting of glacial snow, of course.

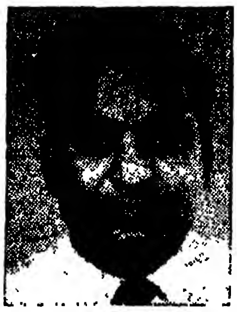
The magnitude of the damage makes it imperative that something must be done. Yet, the task would be staggering. Control the mountain's ice and snow ? Yes, it can be done. We can begin with an exhaustive scientific study of the Himalayan snow and glaciers. The abundant discharges in the Himalayan rivers in monsoon months are the combined drainage from rainfall, snowmelt and glacier

HIMALAYA (*Him* means snow, *alaya* means storehouse) is a Sanskrit word and literally means the storehouse of snow and ice, and is more commonly referred to as the abode of eternal snow.

Geological evidence exists which shows the Himalayas have been formed by violent crumpling of the earth's crust along the southern margin of the great table-land of Central Asia. The uplift of the Himalayas was a gradual process protracted over a very long period. This process had a very marked effect upon the scenery, the topography and the river systems.

During the slow process of uplift, folding and faulting, the rivers were able to keep largely to their original courses. The erosive power of these streams was increased with the increase in their bed slopes. Thus the rivers are formed cutting through the main chains of ranges in deep transverse gorges after flowing for long distances parallel to the trend of the chain. Most of these rivers drain not only the southern slopes of the Himalayan mountains, but, to a large extent, the northern Tibetan slopes as well. In fact, the watershed of the chain is not along the line of highest peaks but quite a distance north of it.

In the outer valleys of the Himalayas the side slopes are so steep that land-slides frequently occur. Simultaneously, the streams are active in cutting down the river beds to reach their base levels. All these streams are very turbulent and are perennial due to regular feeding from snowmelt and glacier drainage from the high mountain.



DR. JAGDISH BAHADUR is Research Officer with the Central Water and Power Research Station at Khadakwasla, Poona. An M Sc from the Lucknow University, he took his Ph D in physics from the Poona University in 1969. He had done research with Dr. Gunnar Ostren after winning a global post-doctorate fellowship offered by the Norwegian Agency for International Development on Snow Hydrology and Glaciology.

After a year of lecturership at Lucknow University, he had worked for the Oil and Natural Gas Commission for some years before coming to Poona. He has worked on snow and glacier hydrology relevant to the Himalayan region. He is now with the Nuclear Research Laboratory, IARI, New Delhi, as Radiation Physicist.

discharge, and not of rainwater alone. To determine their exact contribution separately, we have to undertake field studies in the high mountain catchments. These studies would be of great economic importance to the whole of the northern region.

SNOW, ICE AND GLACIERS. Huge treasures of much-needed fresh water are locked in the world's glaciers. About three-fourths of all the fresh water of the world, equivalent to about 60 years' precipitation over the entire globe, is stored in glacial ice. The glaciers today occupy about 11 per cent of the earth's total land area. The total volume of the world's glaciers, ice fields and ice sheets can only be guessed at and the figure may be somewhere near 30 million cubic kilometres. This mass of frozen water, if melted and drained to the sea, might raise the sea level by about 100 m, thus drowning many populous areas of the world.

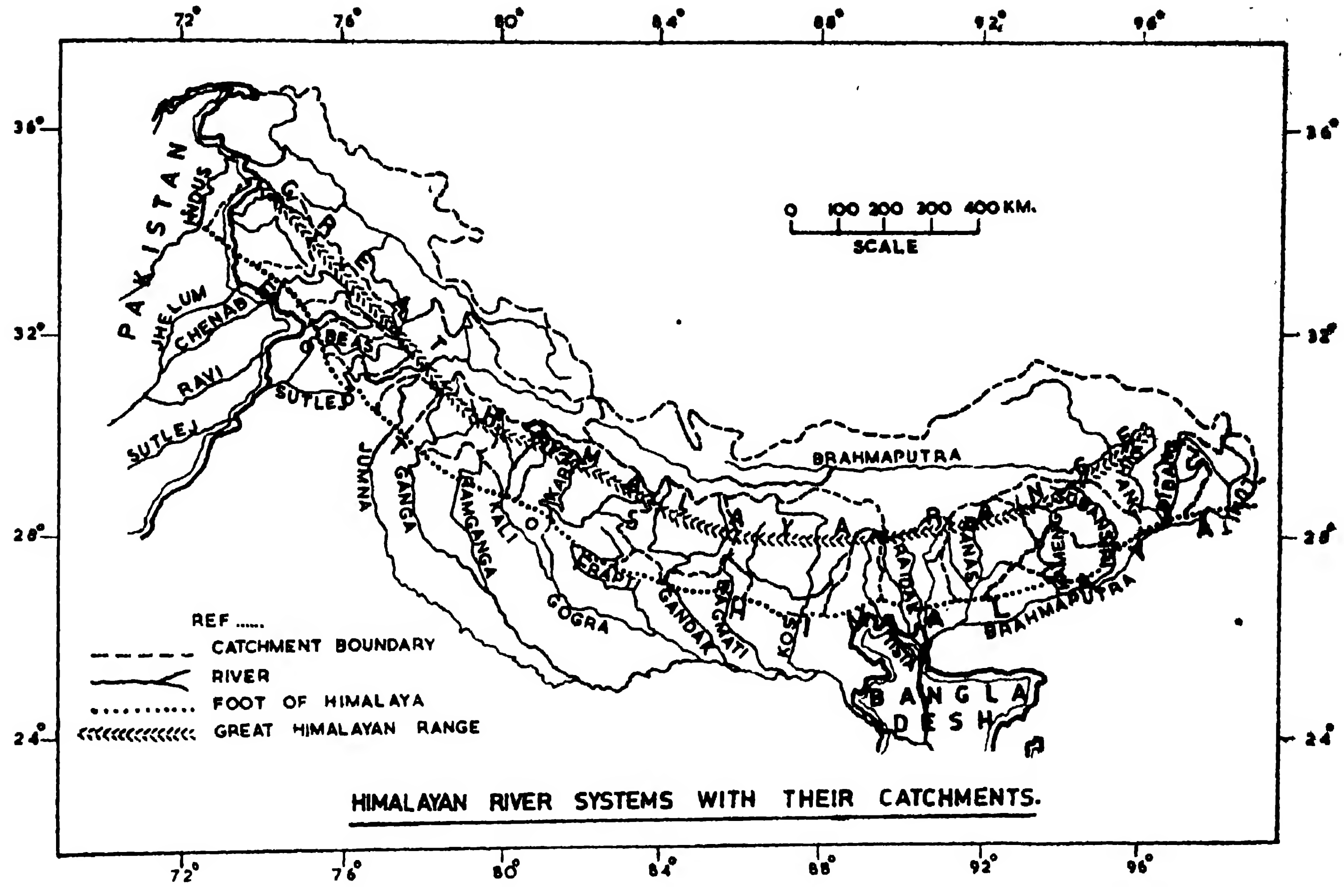
A glacier is a mass of compacted ice originating in a snow field. It occurs in those parts of the earth where the rate of precipitation is greater than the rate of melting of snow. The ideal locations are the polar regions and the higher mountain tracts.

In mountain regions snow accumulates on gentle slopes, in high mountain valleys, in hollows and depressions, and on the summits of dome-like peaks. Because of the weight of accumulated snow, the lower layers become compacted together into dense clear ice with a granular structure throughout, called firn or névé. The ice thus formed is more or less stratified as a result of successive falls of snow and of melting between the snowfalls. The firns have crevasses (cracks in the ice) concealed within them.

THIS happens to be one of nature's most effective means of storing water, both in solid and in liquid form. One of the inherent characteristics is that the release of water is more during warm, dry months and less during cool, wet months of the year. A glacier thus builds up during winter and depletes during the summer and spring months. This gives glaciers some complex hydrologic characteristics because of the changes they undergo in their physical properties during different seasons of a year. For instance, the runoff is minimum in early mornings and maximum in late afternoons. As air temperature rises, the top snow surface on a glacier starts melting, the melt water flows down the snow mass and finds its way on to the body of the glacier through crevasses. This helps melt additional ice. A constant supply of heat from the

SOME IMPORTANT HIMALAYAN GLACIERS

Region	Name of the glacier	Approx. length (km)
Eastern Himalayas	ZEMU	26
Sikkim	KANCHANJUNGA	16
Central Himalayas	MILAM	19
Kumaon	KEDARNATH	15
	GANGOTRI	26
	KOSA	11
Western Himalayas	RUPAL	16
Punjab (Kashmir)	DIYAMIR	11
	SONAPANI	11
	RUNDUN	19
	PUNMAH	27
	RIMO	40
	CHONG KUMDON	19
	NIVAPIN	Not known
Karakoram (North-western Himalayas)	BIAFO	63
	HISPAR	61
	BALTORO	58
	GASHERBRUM	39
	CHOGO LUNGMA	39
	SIACHEN	72
	BATURA	58



HIMALAYAN RIVER SYSTEMS WITH THEIR CATCHMENTS.

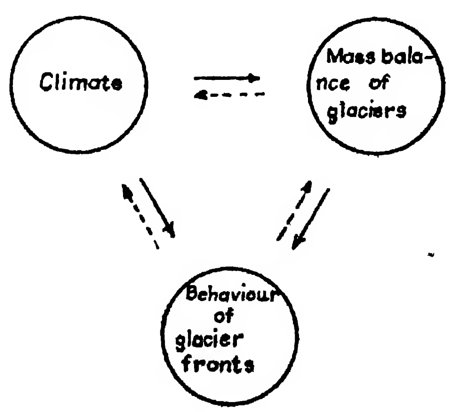
bedrock also contributes to the melting of glacier ice.

Claving depletes most of the glacier. Sometimes glacier-stream flows are sudden, with unexpected high discharges due to glacier bursts. Water releases from snowmelt also depend on the physical state — compactness, thermal state, etc of the snowpack. It has been seen that there are fluctuations in the mass balances of glaciers from year to year.

THE HIMALAYAS. The Himalayan ranges spread over a length of about 2400 km in the east-west direction while the width varies from 150 to 250 km in north-south direction. The Himalayan mountain system is divided into three parallel longitudinal zones : (*i*) the *Greater Himalayas*, the main ranges, rising to an average elevation of 6100 m above mean sea level (asl); (*ii*) The *Lesser Himalayas*, lying south of the Greater Himalayas, are the middle ranges with an average height of 2600-4600 m a.s.l., and (*iii*) the *Outer Himalayas* are between the Lesser Himalayas and the plains, and have an average elevation of 1000-1300 m a.s.l.

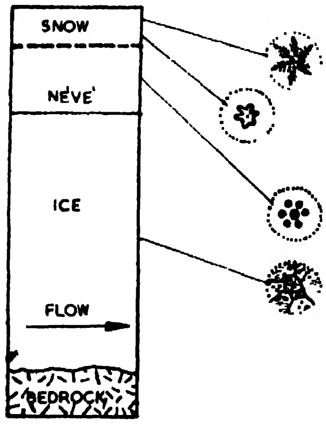
The most active glaciers are generally found in regions receiving the heaviest snowfall, such

Broad concept for glacier data evaluation in relation to climate

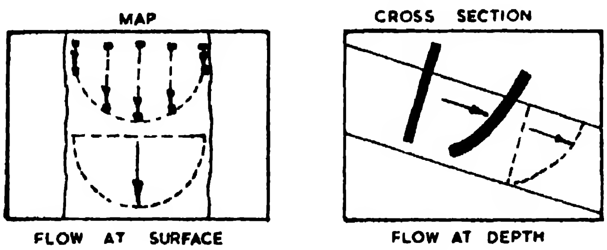


as the maritime flanks of high coastal mountain ranges. There are many other glaciers in the high mountains of the middle and equatorial latitudes. What we see today of the Himalayan snow, ice and glaciers are the withered remnants of older and much more extensive snowfields and ice flows in the region.

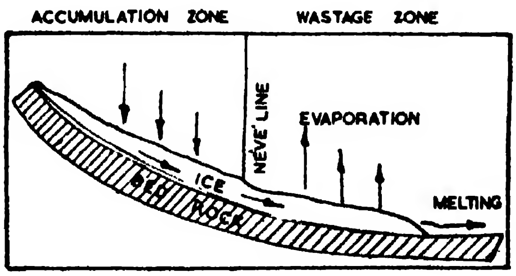
The snowline, ie the lowest limit of perpetual snow, of the Himalayas on the side facing the Indian plains varies in altitude from 4300 m on the east to 5800 m on the west. In Ladakh it lies at about 5500 m and in Hindukush at about 5200 m. The Lesser Himalayas do not support any glaciers as their altitude is below 4600 m — lower than the Himalayan snowline. Only the Greater Himalayas with their innermost ranges above 6100 m are the enormous gathering grounds of snow which feeds multitudes of glaciers, some of which are among the longest in the world outside the polar circles.



FORMATION OF GLACIER ICE FROM SNOW



FLOW OF GLACIER ICE



HOW A VALLEY GLACIER IS FORMED

THE glaciers creep down the mountain side. The greatest movement naturally takes place in the summer when the average temperature is above freezing point. Generally, glaciers descending transversely to the strike of the mountain are shorter in length. Their snouts fluctuate more abruptly. Since these glaciers have a large gradient they descend to levels as low as 2150 to 2450 m, as in Kashmir. On the other hand, glaciers which move in transverse valleys in a direction parallel to the strike of the mountain are less sensitive to variations in their snouts. Their gradient is low and they rarely descend below 3100 m.

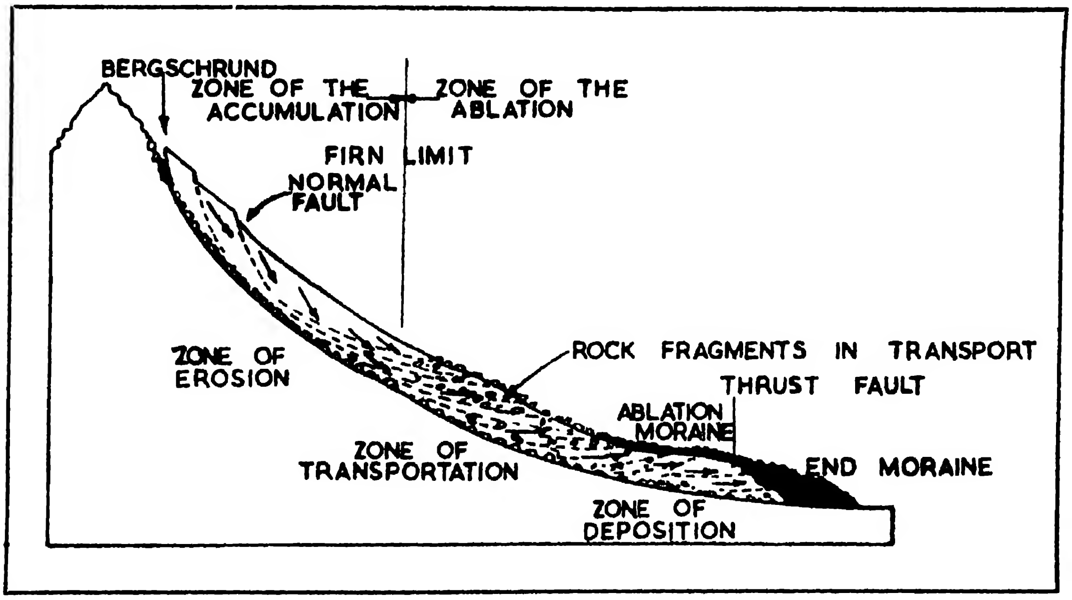
Due to the change in latitude — from 28° in the eastern to 36° towards the western regions — and partly because of heavy rains in the eastern parts of the country, the lower limit for the descent of glaciers in the Himalayan region is not uniform. In the eastern parts they never descend below 4400 m, in the middle or central parts never below 3650 m, but in the western region they may descend as low as 2450 m. The velocity of glacier flow has been observed to vary from a few centimetres to some metres per day. The variations in glacier activity, as observed from their snout position, may be regular, periodic, seasonal or accidental. The Karakoram and Himalayan glaciers show, as Masen observes, no evidence whatsoever of any regular periodic variation corresponding to known weather cycles.

RAIN AND WATER. On an average the Indian subcontinent gets about 113 cm of rainfall per year. It is estimated that about 3700 km^3 of water falls as precipitation. Out of this about 1233 km^3 is lost by evaporation and evapotranspiration, 1670 km^3 is the stream runoff to the sea and about 717 km^3 percolates underground to recharge the groundwater reservoirs. Himalayan rivers discharge about

70 per cent (including about 5 per cent from the central Indian rivers) to the sea while 30 per cent forms the total stream outflows which drain the peninsular region. In extrapeninsular regions, about 15, 25 and 35 per cent of total streamflows are contributed from the western, central and eastern regions respectively. In the peninsular region, east-flowing rivers take about 20 per cent as compared to about 10 per cent of the total annual discharge to oceans of the west-flowing rivers.

The glaciated areas which give us water are over 50,000 km^2 — this forms about 10 per cent of the snowbound areas during winter. A rough estimate shows that they give at least 100 to 200 km^3 of water every year. This forms about 10 to 20 per cent of the water carried by extra-peninsular rivers to the ocean annually.

A glacier at any one time presents only partial patterns of its long-term existence. As snow and glaciers are progeny of climate and are wholly dependent upon elements of climatic environment for their birth and sustaining life, their behaviour should be studied with respect to meteorological conditions. Other glaciological studies embrace research in many allied disciplines such as geomorphology, meteorology and climatology



Glacier abrasion and erosion due to ice flow

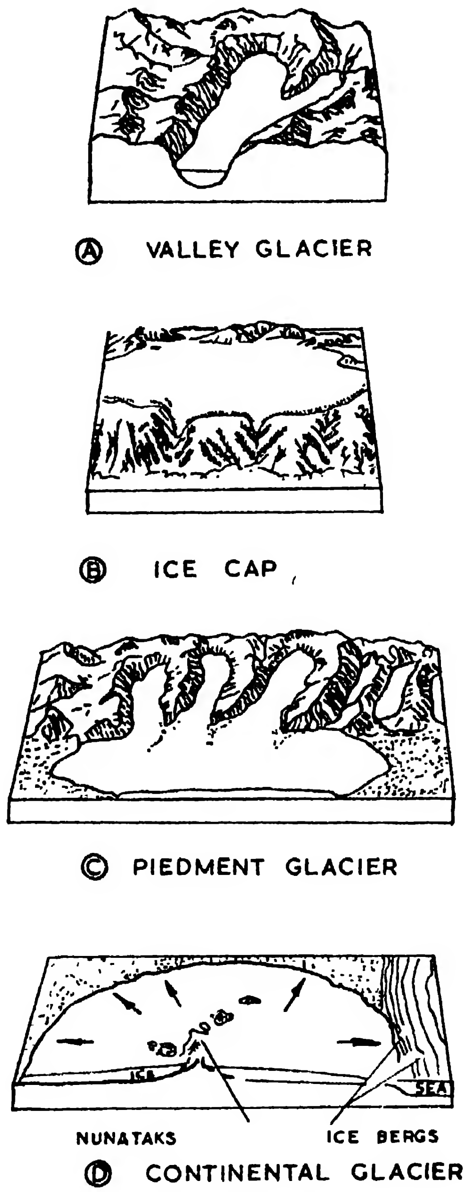
A recent scientific evaluation of glaciers of three basins in Mount Everest by Canadian scientists has given the following data:

	Nangpo Bhota Kosi	Dudh Kosi	Imja Kosi
Total No. of glaciers	68	35	61
Glaciarised area (km^2) ..	106	100	154
Total volume of ice (km^3) ..	6·0	12·1	9·8

It has been observed that the majority of glaciers are very small in size: only seven have a surface area of more than 10 km^2 whereas 68 per cent of them measure less than 1 km^2.

Such detailed inventories are required in respect of the western and central Himalayan regions. This information, through proper engineering techniques, will help regulate the supplies from those natural reservoirs of fresh water. It is of great importance as they release large quantities of water when it is most needed, ie during the premonsoon months.

MODERN TECHNOLOGY. Lately, there has been a world-wide activity for mapping the perennial snow and glaciers in different regions of the globe to assess the fresh water potential in frozen form. This is done through ground survey techniques and by making use of aerial photographs of the terrain. But the Himalayas present many challenges — high altitude, rough terrain, limited communications — which limit



Different kinds of glaciers. The valley glaciers are one to three kilometres wide, whereas the continental glaciers would cover hundreds of thousands of square kilometres

exploration by ground survey parties. Using an aircraft is difficult in the rarefied atmosphere at high altitudes for landing and, still more, for taking off.

A varied choice of technology is now available to offset the handicaps of high altitudes. Remote sensing techniques and earth resources satellites offer great promise for evaluating the potential of Himalayan water resources for proper exploitation.

From APT (automatic photo transmission) pictures it has been possible to study the approximate area of snow cover and altitudes of snowhives. More information on snow cover would be available from the forthcoming earth resources satellites. The two earth resources technology satellites, proposed to be launched in 1972 and 1973, will carry multispectral television camera and multispectral scanner systems which can telemeter the acquired data to ground stations for distribution in different formats. The coordination by India with these international programmes for the collection of hydrological data, plans for which are underway, would be of great advantage in evaluating Himalayan water resources.

IMPORTANCE OF GLACIOLOGY IN INDIA. All the northern rivers of India are perennial due to regulation by snowmelt and glacier drainage. The melting ice not only can help purify rivers but, channelled through spillways, it may set new hydroelectric generators supplying cheap and plentiful electricity. An assessment of the water equivalent of the melting snow pack and the determination of drainage characteristics of various glaciers in the high mountains have importance in artificially regulating the Himalayan river systems for

APPROXIMATE GLACIER DATA OF NORTH WESTERN HIMALAYAN CATCHMENTS

River	Glacier area (km^2)	% of glacier area	Mean glacier elevation (m)
Indus	3,735	12	6,250
Jhelum	368	1	5,500
Chenab	3,820	13	5,800
Ravi	259	3	5,200
Beas	717	5	5,800
Sutlej	6,392	11	6,100
Jamuna	339	3	5,500

An icy womb, a river born...

Photograph on the left shows the Gaumukh (3900 m) ice-tunnel — birth-place of the river Bhagirathi (a tributary of Ganga). In the background, the high-rising Bhagirathi group of snow-covered peaks (I-6856, II-6512 and III-6954 m) are flanked by moraine deposits on both sides. At right is a closer view of the ice-tunnel with several ice blocks with moraine deposits on the ground

greater hydroelectric power generation, irrigation and other benefits.

Glacier hydrology is highly developed in some western countries. The Swiss hydroecologist, Dr. Hans Stauber, plans to harness the glaciers of southern Greenland with the aid of solar heat. Hydroelectric plants would be powered by run-off melted from the " eternal snow ". Norway, Iceland, Switzerland and France are obviously getting electricity from many glacier-fed rivers. The USSR is harnessing the Vakhsh, which originates from the glaciers of the Pamirs, by erecting a 300-metre-high dam in a deep gorge, which will eventually turn into a man-made lake. With this the Vakhsh will energise nine turbines of the Nurela Power Plant generating 12,000 million kilowatt hours of power.

Systematic glaciohydrological investigations will include the compilation of an inventory of all perennial and annual snow and ice masses throughout the mountains, their areas, volumes and the moisture they contain. The establishment of hydrological observatories in snow — and ice-bound catchments and measurement of mass balance of glaciers will enable an assessment of the exact volume of water supplied from different catchments. These investigations will benefit greatly in the regulation of multipurpose hydraulic structures and help create more confidence in taking up many new development projects. For instance, it is estimated that Himachal Pradesh has an aggregate hydel potential of 8248 MW in its five river systems which comprise the Chenab, Ravi, Beas, Sutlej, and Jamuna. This hydroelectric potential is larger than that of Switzerland, Germany and Norway and compares favourably with that of France and Sweden.

Remote sensing

Remote sensing is the technique of sensing from a distance using ultra-violet, infrared and radio-frequency wavelengths to supplement the visible region sensors. A broader definition of remote sensing is the joint efforts of using modern sensors, data processing equipment, information theory and processing methodology, communication theory and devices, space and airborne vehicles, and large systems theory and practices in co-ordination with the relevant earth sciences disciplines. This definition emphasises the multi-disciplinary aspects of remote sensing for carrying out aerial and space surveys of earth.

round-up of research

DRUGS

A Cure for Stomach Ulcers?

A NEW drug which may prove to be more effective in the treatment of ulcers of the stomach and duodenum has been discovered by a team of pharmacologists belonging to the Smith, Kline and French Research Institute in Welwyn Garden City, Hertfordshire, England. They have shown in an article in *Nature* (*236*, 285, 21 April 1972) that the drug called burimamide blocks the stimulation of gastric acid secretion by histamine in the stomachs of rats and dogs.

Histamine, produced from the amino-acid histidine present in the haemoglobin of blood, is widely distributed in the body tissues and has powerful biological actions on muscles, blood capillaries, gastric secretion and possibly on the central nervous system. In fact, a variety of smooth muscles such as those in the gut and in the bronchi are stimulated to contract by the release of histamine. Typical antihistamine drugs used now, such as mepyramine, are effective against bronchial constriction in asthma and in the treatment of various allergies resulting from sudden excessive release of histamine from the tissues into the blood. However, they are ineffective against histamine-induced stimulation of acid secretion by the stomach, as also the effects of histamine on the contraction of heart and uterus.

This is because there are two different kinds of histamine receptors in the cells. The cells of the muscles which cause bronchial constriction have one type of receptor (H_1), while those which secrete acid in the stomach have the other type (H_2). Drs. J. W. Black, W. A. M. Duncan, C. J. Durant, C. R. Ganellin and E. M. Parsons have now systematically examined the properties of H_1 and H_2 receptors by studying the agonist and antagonist action of a wide range of compounds on histamine responses. Their study, lasting nearly a decade, involved the synthesis and testing of more than 700 compounds.

In their experiments they used five different tissue systems such as the contractions of isolated guinea-pig intestine (H_1), the contraction of rat stomach (H_1), the contraction frequency of isolated guinea-pig heart muscle (H_2), gastric acid secretion in rat stomach (H_2) and electrically-induced contractions of rat uterus (H_2). The compounds they studied were mostly slightly modified forms of histamine. For example, from an estimation of the relative agonist activity of each of a series of methyl derivatives of histamine on both guinea-pig intestine (H_1) and guinea-pig heart (H_2), they found that 4-methylhistamine evoked H_2 responses, while 2-methylhistamine evoked H_1 responses. They have produced pharmacological evidence which suggests that there are true differences in the interactions of these histamine analogues with the different receptors. The tests also established that the H_2 receptors form a homologus group.

Among the substances tested as potential antagonists of the H_2 receptors, the British scientists discovered an interesting new compound, burimamide, a thio-urea analogue of histamine. This compound was found to be effective in counteracting the action of histamine in the contraction of heart and uterus. Burimamide also antagonised H_2 responses evoked by various histamine analogues, such as 4-methylhistamine. On the other hand, the drug failed to antagonise H_1 responses. They established that burimamide is a specific competitive antagonist of H_2 receptors.

Burimamide blocked the stimulation of gastric acid secretion normally produced by histamine in the stomachs of anaesthetised rats. Further, it inhibited the secretion of gastric acid evoked by the injection of the analogue of gastrin, pentagastrin in dogs and human volunteers. Now the hormone gastrin, released from the digestive tract after feeding, is known to play an important part in triggering gastric acid secretion. Blockade of this response by burimamide lends powerful support to the hypothesis that gastrin effects are mediated through a local release of histamine in the stomach. Thus using burimamide it may now be possible to clarify the role of histamine release and gastric acid secretion in the formation of stomach ulcers. Probably, the drug may also provide a more effective alternative to those currently being used in the treatment of ulcers.

AGRICULTURE

Bacteria May Increase World Food Production

THE high yielding strains of rice, wheat and other cereals which have been introduced during the past few years to usher in an era of ' green revolution ' in many developing nations need supplies of large amounts of nitrogenous fertilisers. Apart from the hazards that may result from the massive use of such fertilisers, this requirement also places an insupportable economic burden on nations introducing such varieties to feed their ever-increasing population. This is because the basic manufacturing method for fertilisers is costly and consumes a lot of energy. If plant geneticists could somehow select strains of high-yielding cereals which require little in the way of fertilisers, it might, of course, be possible to find means of circumventing this biggest obstacle for increasing world food production. Though such a possibility appears very remote at present, a silver lining is the work of Drs. R. A. Dixon and J. R. Postgate of the Agricultural Research Council's Unit of Nitrogen Fixation, University of Sussex, Brighton, England who through ' genetic engineering ' have created a new species of bacteria capable of fixing atmospheric nitrogen.

Nitrogen forms an essential component of proteins and nucleic acids, and is vital to all living organisms. The atmospheric nitrogen is converted into organic nitrogen compounds essential for the growth and metabolism of plants by what are known as ' nitrogen-fixing bacteria'. The process by which the bacteria does this is not yet completely understood and is one of the chief areas of agricultural research. On average, about half the nitrogen for plant growth if provided by nitrogen-fixing bacteria while the other half by organic manure and man-made fertilisers.

Drs. Dixon and Postgate discuss in *Nature* (*273*, 102, 12 May 1972) how they have successfully transferred the structural and regulatory nitrogen fixation genes (nif) from a bacterium called *Klebsiella pneumoniae* to a strain of the common gut bacterium *Escherichia coli* (*E. coli* C), which does not naturally fix nitrogen. Although the precise nature of the nitrogenase proteins made in the recipient *E. coli* has yet to be elucidated, the transfer of functional nitrogen fixation genes from one bacterial species to another of a different genus is a considerable and exciting achievement. Though the physical state and mode of replication of nif DNA in *E. coli* cells have yet to be determined, it would be no great surprise, however, if they are found to persist as a small closed circular piece of DNA independent of the *E. coli* chromosome. If this is the case, it may be possible to obtain the nif genes into a plasmid state which would facilitate both attempts to transfer the genes to other non-nitrogen-fixing microorganisms and attempts physically to isolate them. This would help new strains of nitrogen-fixing bacteria to be cultivated and spread on crops to increase growth.

The significance of the work of the British scientists lies in the fact that the methods used for the genetic manipulation of new characteristics into bacteria might also be used for passing the same characteristics to a strain of, say, a commercially important plant like high-yielding wheat. Plant breeders may thus ultimately be able to build up high yielding nitrogen-fixing strains of cereals. These strains obviously will have the inherent capacity to fix atmospheric nitrogen in sufficient amounts to meet their own needs, thus eliminating the need for nitrogenous fertilisers. No doubt, this will be a herculean task and will not be achieved in the near future. But considering the bleak future the vast majority of world population faces, this task should be immediately taken in hand.

PAEDIATRICS

How to Make Infants Walk Sooner

BRIEF daily exercise of the walking and placing reflexes in the new born leads to an earlier onset of walking. This is the conclusion of a study conducted on 24 infants by Dr. P. R. Zelazo of the Department of Social Relations, Harvard University, Cambridge, Massachusetts, USA together with Drs. N. A. Zelazo and S. Kolb of Boston University.

It is already known that if a newborn infant is held under his arms and his bare feet are permitted to touch a flat surface, he will perform well-coordinated walking movements. Similarly,

if the dorsa of his feet are drawn against the edge of a flat surface, he will perform placing movements much like those of a kitten. However, normally, these walking and placing reflexes disappear by about 8 weeks. Dr. Zelazo and his colleagues now claim that these reflexes can be preserved intact beyond the second month through active daily exercise.

In the experiments reported in *Science* (*176*, 314, 21 April 1972), they divided the 24 children into four groups of 6 infants each. Infants in the first group, known as the 'active-exercise group', received stimulation of the walking and placing reflexes four times a day in sessions of three minutes duration. In the second group, called the 'passive-exercise group', walking and placing reflexes were not elicited but the infant's legs and arms were gently exercised in a pumping motion while the child was lying on his back in his crib or infant seat. These children were tested every week with a third group of children who received no special exercises. The exercises were continued from the beginning of the second through the end of the eight week. The fourth group of infants was tested only at the end of the eighth week in order to remove any effects the tests had on the third group.

By the end of eight weeks, a strong increase in walking movements was observed in infants who had been encouraged to use their walking reflexes. They made an average of 30 walking movements a minute during tests, while those in the passive and non-exercise groups averaged between 5 and 6 movements. In fact, individual records revealed that the performance of the six infants in the active-exercise group increased between 32 and 617 per cent as compared to that at the second week. It was also observed that the placing responses in active-exercise infants were higher than those of the other groups.

After the tests were over, the parents of all the 24 children were informed as to how they could further encourage their children to walk during the first year. The mothers reported later the dates and the ages at which their infants started walking alone. On average, children begin to walk at about 14 months. However, infants of the active-exercise group started walking during their tenth month, and children in the other groups when they were between 11·5 and 12·5 months old.

The American team concludes that there appears to be a critical period during which the walking response can be transformed intact from a reflexive to an instrumental action. There is little doubt that learning occurred in the infants of the first group who walked 5 to 6 weeks before the others. It is conceivable that the function of the walking reflex may be to assist the infant in developing mobility and that it should therefore be stimulated. A major benefit of this mobility may be that it promotes an earlier sense of competence.

CANCER

Is Immunotherapy a Treatment for Cancers?

IS it possible to stimulate the body's natural defences against cancerous cells so that it will reject tumours in the same way as a transplanted organ such as heart or kidney is? Previous attempts to induce or augment immunological responsiveness against human tumours have been relatively unsuccessful. While some beneficial results have been claimed, the theoretical possibility of enhancement of tumour growth by this procedure has so far deterred the majority of cancer research workers. However, two British doctors belonging to the Department of Immunology, Royal Infirmary, Manchester, England have now in a report in the *British Medical Journal* (*2*, 183, 22 April 1972) presented an interesting study of active immunotherapy in advanced cancer with histological evidence of tumour destruction.

The study was conducted on 12 patients (6 males and 6 females with advanced carcinoma in ovary, rectum and stomach and melanoma in perineum and leg) who were all considered unsuitable for any conventional form of therapy like surgery, radiotherapy or drugs. In the present study, doses of vaccine prepared from extracts of the patients' own tumours were used, and the experimental nature of the proposed therapy was explained in detail to either the patient or a near relative.

To prepare the vaccine, samples of tumour tissue were surgically removed from soft parts of primary tumours and homogenates prepared. These homogenates were then emulsified with Freund adjuvant to which was added heat-killed human strain, *Mycobacterium tuberculosis.*

This is because previous attempts to induce immune response using the patients' own tumour extracts have indicated that better clinical results are obtained when adjuvants, particularly mycobacterial ones, are used. The vaccine was injected at intervals of two to four weeks into the skins of the patients in two doses of 0·1 or 0·2 cc.

The patients as well as their tumour tissues were examined at frequent intervals during and after immunotherapy. All patients complained of an influenza-like illness lasting usually 24 to 36 hours after receiving the vaccine. However, in many of the patients clinically observable changes took place in the tumour tissues after this. The tumours became tender and soft and ultimately diminished in size. Evidence of tumour destruction was observed in 10 patients. In seven of the patients there was a marked improvement in general health for weeks or months, and symptoms referrable to tumours disappeared. Three of the patients are still in good health more than a year after the tumour vaccine was given.

Drs. G. Taylor and J. L. I. Odili point out that, on ethical grounds, it is not advisable to treat by immunotherapy patients who might be improved by conventional forms of therapy. They further observe that since cancer in an advanced form is highly variable, it is necessary to have a very large controlled clinical trial to prove the efficacy of immunotherapy as a treatment for cancers. In any case, while immunotherapy reduces the tumour size in many patients, it does not result in a cure. With a better understanding of the mechanisms of tumour rejection, it might be possible to develop better vaccines, and to determine which patients are likely to derive maximum benefit from immunotherapy. However, according to them, it is very unlikely that immunotherapy will ever replace other conventional forms of therapy. It could only become a useful adjunct to surgery, radiotherapy and chemotherapy.

TECHNOLOGY

Process for Making Steels Ultra-strong

TECHNIQUES for manufacturing ultra-high strength steels were developed decades ago by trial and error. Yet all such steels have some undesirable characteristics such as low fracture toughness at high levels of yield strength. Until recently, very little effort has been directed towards the use of the latest ideas on alloying and macromechanics of fracture to improve the existing alloys or to find new ones with better combinations of properties.

A team of materials scientists belonging to the University of California, Department of Materials Science and Engineering, Berkeley, California, USA has now learned how to increase the fracture toughness of steels having yield strength in excess of 200,000 pounds per square inch by as much as 70 per cent by using a treatment that differs significantly from the normal commercial practice for quenched and tempered low alloy steels. Their technique is bound to be of immediate practical interest to the steel industry.

Usually in the manufacture of high strength steels heating is carried out until a temperature is reached at which the size of grains formed in the steel is minimised. This is called the austenising temperature, and occurs at about 1,000°C. After this, the steel is quenched extremely rapidly by immersing in iced brine before tempering at a temperature that will optimise the mechanical properties. In commercial practice, the range of austenising temperatures recommended is between 835°C to 915°C.

Drs. V. F Zackay, E. R. Parker, R. D. Goolsby and W. E. Wood have reported their studies in *Nature Physical Science* (*236*, 108, 17 April 1972). They find that for a special secondary hardening steel (5% Mo 0·60% Mn 0·30% C) and several commercial low alloy medium carbon steels austenising above about 1,100°C and quenching in iced brine increases the fracture toughness by a factor of 2. They also found that increasing the temperature resulted in an increase in the grain size in the steels. Yield and tensile strengths, however, were relatively insensitive to the austenising temperature. This was shown by varying the temperature from 1,255°C to 895°C.

They also investigated the relation between austenising temperature and quenching rate for a widely used commercial steel in USA (AISI 4340). In this investigation, three different quenching media, viz, iced brine, water and oil were used. First, using the conventional austenising temperature of 870°C, they quenched samples of the commercial steel in all the three media and found that only

(Continued on page 58)

points of view

The Ganga-Cauvery Link

THE United Nations team of experts who visited India twice, in December 1971 and in March this year, to study the feasibility of linking the Ganga with the Cauvery is expected to submit its report this month. The team is headed by Dr. Joseph Barnea, Director of the Resources and Transport Division of the UN in New York.

The project, conceived by Dr. K. L. Rao, Union Minister of State for Irrigation and Power, seeks to utilise the surplus monsoon waters of the Ganga, now being wasted or causing heavy floods The waters will be diverted from near Patna in Bihar to the Mettur Reservoir on the Cauvery in Tamil Nadu, through a canal about 3,420 km long, 76 metres wide and 3 to 7 metres deep. The water will be lifted to a height of 700 metres at the source and at various points en route so that it flows under gravity. Part of an all-India river grid system, the canal will link several rivers, including the Godavari and the Krishna on the way. A series of reservoirs and cross channels will help irrigate dry and remote areas along the canal. Besides, the project will control floods in the Ganga basin and promote inland water transport.

The project, if feasible, may take full shape only in the next century. It will cost thousands of crores of rupees. Even to prepare the project report, it may take about ten years and over Rs. 50 crores.

But there has hardly been any public debate on such an important national project involving a "fantastic amount" of funds. Is such an ambitious project really necessary? How much water will finally flow down the canal? What will be the benefit to various states? And will the net benefits justify the enormous efforts and investment?

Some feel the plan is too ambitious when funds are not available even for modest but sound irrigation schemes. Others think that certain alternative plans (see "Focus", p. 6, SCIENCE TODAY, *September 1971) deserve higher priority. Dr. K. N. Raj, an economist, had recently suggested that an integrated Ganga-Brahmaputra development scheme would be more feasible, and that the Ganga waters should be diverted to arid Rajasthan. Dr. Raj had also estimated that 6,500 MW of power will be needed to lift the surplus monsoon waters to the required height. This alone will cost Rs. 1,500 crores. Also, ways have to be found to utilise this power during the non-monsoon period.*

Tamil Nadu will be at the tail-end of the project. Here an irrigation researcher analyses the project, the water flow in the canal, the seepage loss, and how far will it help to meet the state's future water requirements.

Is It Necessary?

P. KUMARASWAMY

IN an article in *The Hindu*, 24 August 1969, Dr. K. L. Rao had discussed the need for connecting the Ganga with the Cauvery. He had also suggested a tentative alignment for the proposed canal. However, the project seems to have been born more out of the dreams of persons like Subramanya Bharati, S. Srinivasa Iyengar and Dr. C. P. Ramaswamy Aiyar than on any sound hydrological considerations. Nor did Dr. Rao discuss the most important factor — the flow through the canal. Instead, he dealt mainly with the question of alignment.

If the designer is permitted to lift the canal waters, any number of alignments can be suggested. But this can be done at a later stage of planning. The main parameter now is the amount of water available in the Ganga and the head discharge of the canal at Patna. And whether the project is really necessary, and if so, whether it is possible hydrologically.

Tamil Nadu has a total area of about 13 million hectares, according to data available in village papers. It receives a mean annual rainfall of 946 mm. The mean total volume of rainfall over the state is therefore about 123 million cubic metres. Out of the total land available, 4·568 million hectares, comprising forests (2 m ha), barren and unculturable lands (0·842 m ha), land put to non-agricultural uses like village sites and townships (1·448 m ha) and permanent pastures and other grazing lands (0·278 m ha), need not be irrigated.

The total land that will be ultimately irrigated therefore is about 8·4 million hectares. The area now sown is about 6 million hectares; the area sown more than once is about 1 million hectares. Projecting into the future the same ratio between the two, the ultimate gross sowing area is estimated at 9·7 million hectares. There will be no necessity to exceed this limit at any time. Considering only paddy cultivation and assuming a water duty of 70 hectares per million cubic metres, the total quantity of water required to irrigate this area is 139 million cubic metres.

Now the drinking water requirements. According to the 1971 Census, Tamil Nadu has a

population of about 41 million; the rate of its increase is 2·3 per cent per annum. Because of the intensive family planning measures, we may assume that the population will stabilise around 60 million by the end of this century. For further computations, therefore, we can take this as the ultimate constant population. Taking 80 cubic metres per head per year as the domestic water requirement, such a population will need about 5 billion cubic metres of water a year. The industrial water supply required, including the proposed industries, is tentatively assumed to be about 20 billion cubic metres. Taking all these together, Tamil Nadu will need 164 billion cubic metres by the end of this century.

ASSUMING 50 per cent as the rainfall utilisation factor (including surface run-off and ground water, and excluding all losses due to evaporation, etc), the rainfall will provide about 62 billion cubic metres of water. Hence, water that has to be imported from outside is about 102 billion cubic metres. Since the river basins of Tamil Nadu overlap with its neighbouring states at the head reaches of rivers such as the Amaravathy, Bhavani, Cauvery, Pennaiyaru, Palaru, etc, about 15 billion cubic metres of water is already being imported from Kerala (3 billion cu m), Mysore (11 billion cu m) and Andhra (1 billion cu m).

Taking into account the potential of these states, a further importable surplus of 56 billion cubic metres (Kerala 12 billion cu m, Mysore 6 billion cu m and Andhra 38 billion cu m) of water is likely to be available after satisfying all their needs. Thus, out of the 102 billion cubic metres to be imported, 71 billion cubic metres can come from Kerala, Mysore and Andhra. While working out the above figures, the volume of rain falling over these states alone has been taken into account; the quantity that runs off from the northern states to Mysore and Andhra Pradesh has not been included. It is estimated that Tamil Nadu can expect 28, 23 and 3 billion cu m respectively from the Godavari, Krishna and Penneru basins. And in that case, there will be no necessity to import water from basins north of Godavari.

What is the amount of surplus water available from the Ganga? Dr. Rao estimates this at 10 to 20 million acre feet. In metric units, this amounts to 12 to 25 billion cu m. Taking an average of 18 billion cu m, it is clear that this is insufficient to bring any benefit to Tamil Nadu. More recently, Dr. Rao seems to have given the figure of 40,000 cusecs as the discharge in the feeder canal at its head near Patna. For this head discharge and for the dimensions of the canal estimated on the alignment and bedslope suggested by Dr. Rao, the discharge is not even sufficient to take care of the expected seepage losses from the canal because of the long distance involved. The seepage and evaporation loss from the canal alone, ignoring losses from the numerous intervening reservoirs, is estimated at about 60 billion cu m per year which is much more than the surplus at Ganga as anticipated by Dr. Rao.

IT is hence clear that the Ganga-Cauvery link will be a costly and ineffective project. The water that will finally reach Tamil Nadu after meeting the needs of the states along the canal and after seepage losses will be almost negligible. Tamil Nadu will become only the tail-end ayacut of a vast and complicated irrigation system with numerous intervening reservoirs, whose operation and control will depend upon the concurrence, whims and fancies of the Central Government as well as the governments of all the states through which the canal will pass.

There are other limitations too. If seepage from the canal is to be eliminated, the canal will have to be suitably lined. This will increase the cost of the project enormously. Tamil Nadu cannot be expected to share such a financial burden, especially when the resultant water flow into it is meagre and also unreliable.

Dr. Rao has proposed that the canal waters be pumped through a total "Head Loss Height" of about 762 metres ultimately. For this, we need a power supply of about 13,000 megawatts. Such a heavy expenditure of power is a waste considering the benefits that result. If Dr. Rao had suggested an alignment which had a steep fall at a suitable locality so that the hydro-electric power generated at this site could be utilised to pump water at other places, it would have been technically and economically a better proposal.

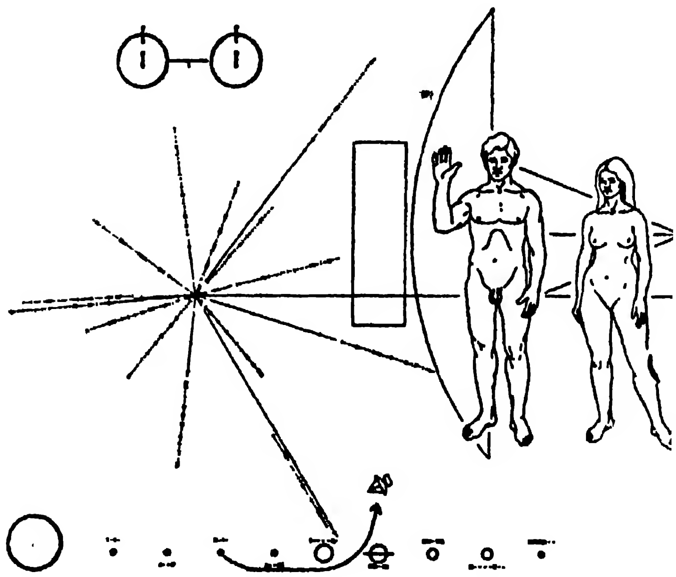
Dr. Rao had mentioned the name of Sir Arthur Cotton in his article, but this has only introduced some confusion. Connecting the rivers by a navigation canal is one thing, and by an irrigation canal is an entirely different and complex matter. The feasibility of connection by a navigation canal whose bottom need not have a bedslope does not automatically prove the feasibility of an interlinking irrigation canal.

[Dr. P. Kumaraswamy is Director of the Irrigation Research Station at Poondi, Tamil Nadu.]

The Martians don't wear clothes? They do!

IT was designed with care and a lot of thought — a universal message that any intelligent being can read. When the plaque was ready, it was placed aboard the Pioneer 10 spacecraft that was launched last March on a 2-year space journey towards Jupiter (see SCIENCE TODAY April 1972, p. 22). The idea was if any inhabitant of the outer space chanced upon it, he could immediately figure out where it had come from, who sent it and when. Now that Pioneer is three months and several million kilometres way out in space, the designers — astronomers Carl Sagan and Frank Drake — are not so sure that's the only idea there is. Their doubts spring from a spate of not-so-laudatory letters.

One correspondent found the man's upraised arm giving a Nazi salute. Here the militant Women's Libbers took over: the proud gesture, and the fact of the man being taller than the woman smelt of male chauvinists. (The designers had intended to show the working of the human hand — its movement and the position of the fingers and the thumb. The 'passive'



stance of the woman was intended to show the working of the hip. Also, the designers had thought, most men are taller than most women.)

After Women's Libbers, came the racists. Some thought the couple was white; no black, said some. The truth is half-way. Linda Sagan (Carl Sagan's wife) who made the drawing wanted to show the man as negro and the woman as oriental — the diversity of human race in a nutshell.

Make way for the moralists! In fact some newspapers in the US did just that: some censored away the male genitals and the female nipples. Those who didn't were attacked for printing 'filth'; again some were blamed for not showing all of the woman's.

They had thought of showing the woman giving birth, said astronomer Drake recently, but that would have complicated matters very much.

Why Wait for Science

Sarcastic Science she would like to know
In her complacent ministry of fear
How we propose to get away from here
When she has made things so we have to go
Or be wiped out. Will she be asked to show
Us how by rocket we may hope to steer
To some star off there say a half light-year
Through temperature of absolute zero?
Why wait for Science to supply the how
When any amateur can tell it now?
The way to go away should be the same
As fifty million years ago we came —
If anyone remembers how that was.
I have a theory, but it hardly does.

ROBERT FROST

[Robert Frost's poem dedicated to Dr. George B. Kistiakowsky appeared in the 24 April issue of Chemical & Engineering News.*]*

A virility game?

WE call it rugby. The British call it rugger. The Americans call it football. Patrick Ryan, the inveterate *Punch* man and the 'last-worder' in *New Scientist* has something more to add by way of description, after he read an American psychiatrist describe watching football a substitute for virility. Mr. Ryan may not be taking sides, but this is what he has to say:

And wonder if anyone but Freud could conceive of a less heterosexual form of human multiple activity than the rugby scrum? Can it be right and proper for 16 grown men to lock themselves in embraces of Kama Sutra complexity, pushing rhythmically, grunting vastly and raising communal steam? Can any front row forward look his marriage counsellor in the face and contend that it is in the natural order of things for a chap to spend the bulk of his Saturday afternoon cuddled cheek to cheek with two gentlemen strangers? And can those other members of the scrum in less intimate positions consider it biologically appropriate to pass similar periods with their arms locked lovingly about their adjacent male partners and their heads simultaneously plunged between the near and off-side buttocks of two of their best friends? ■

A melancholy paradox

As a friend and I sat outside our hooch, gazing skyward, pondering the now almost commonplace achievement of America's placing two men on the Moon, it occurred to me that there is a melancholy paradox in the fact that our nation possesses the brilliance to place the two of them up there and the stupidity to place the two of us here.

Letter from an American soldier in Viet Nam in *Time* magazine

awards & appointments

THINGS hadn't quite settled when the first appointments in space and atomic research were made in January this year, barely a month after Dr. Sarabhai's death. Space and atomic research were bifurcated, with Mr. H. N. Sethna taking over as the Chairman of the Atomic Energy Commission, while continuing as the director of the Bhabha Atomic Research Centre at Trombay. Dr. M. G. K. Menon became the head of the Space Research Organisation, besides being the Director of the Tata Institute of Fundamental Research, Bombay, and the Chairman of the newly created Electronics Commission.

The government has now set up a Space Commission, on the lines of the Atomic Energy Commission and the Electronics Commission, under a new Department of Space, to promote the rapid development of space science. **Dr. Satish Dhawan,** Director of the Indian Institute of Science, Bangalore, heads the Commission. He will also be the Secretary to the Department of Space, while continuing in his present post. The Commission will have its headquarters in Bangalore.

Dr. Dhawan, 52, specialised in aeronautics from California Institute of Technology, USA, before he joined the Department of Aeronautical Engineering, Indian Institute of Science, in 1951 and has been with the Institute ever since, becoming its director in 1963. Here he constructed supersonic and transonic wind tunnels and set up the High-speed Aerodynamics Laboratory.

A Government resolution establishing the commission says: " The Government attaches the highest importance to the exploration of outer space and the development of space science and technology and their applications." The sophistication of the technology and its varied applications, the resolution said, demand that the commission should be " free from all non-essential restrictions and needlessly inelastic rules ". The commission, with four to seven members, will have full executive and financial powers. It will formulate the space policy and also implement it.

In atomic research, **Dr. Raja Ramanna** now becomes the Director of the BARC. He had been the director of the Physics and Bio-medical Groups at BARC.

Forty-seven-year old Dr. Ramanna was mainly associated with the designing of the research reactors, Apsara and Zerlina, at Trombay, in collaboration with the late Dr. H. J. Bhabha.

Dr. Menon, it is learnt, will now be exclusively with the Electronics Commission. **Dr. Devendra Lal,** head of the Geophysics Group, TIFR, is likely to succeed him as the Director of the Physical Research Laboratory, Ahmedabad. And that still leaves one question open: Who will succeed Dr. Menon as Director of TIFR?

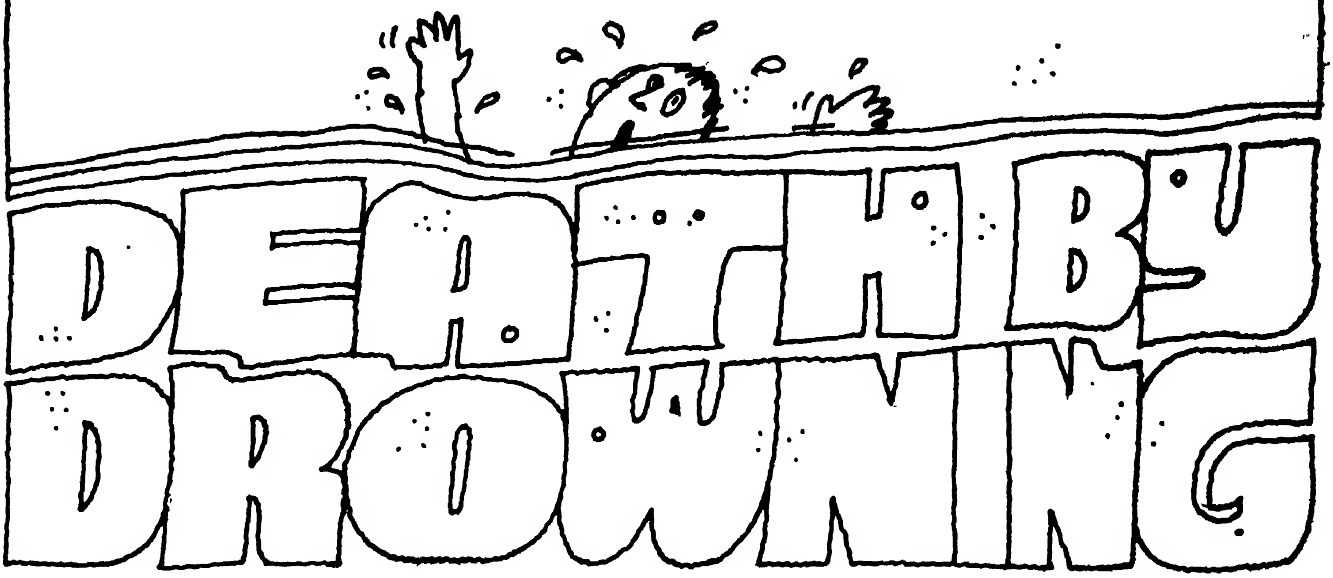
* * *

Prof. P. K. Jena has taken over as the new Director of the Regional Research Laboratory, Bhubaneswar. A specialist in physical chemistry and extractive metallurgy, Prof. Jena was till recently Professor in Process Metallurgy at the Banaras Hindu University.

* * *

Prof. P. N. Wahi, Director-General of the Indian Council of Medical Research, has won the first Sandoz Award for cancer research for his services in the fields of cancer research and education.

PRAVIN KUMAR



DEATH BY DROWNING

It may happen to you while riding the surf, sailing in a boat or crossing a street in a heavy downpour. You are carried out of your depth by a swift current; the boat may capsize; you may fall into a nullah in the flooded street.

Then water, which laves your limbs in the bathroom, which keeps your vital systems ticking, suddenly becomes the destroyer of life. Water invades your lungs in a choking inrush. Your blood ceases to be blood. And in a few moments some bubbles and some clothing, perhaps, are the only traces left of you as the waters close overhead

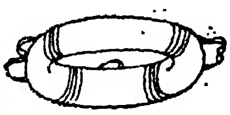
DEATH by drowning is not a dramatic or spectacular mode of fading out. (More people are killed in land accidents.) Unless, of course, it is a goodly crowd, as when the *Titanic* sank in 1912, with a loss of 1,500 lives by drowning or exposure to cold, or the loss of the nuclear submarine *Thresher* (1963) with 129 lives. Mostly it is a lonely death. You are lucky if your cries are heard above the wind's moaning and the waves' slapping and somebody in a split second decides that your life is as valuable as his own.

Not all the drowned live afterwards in deathless verse, or prose, like Edward King whose death by drowning in the Irish Channel is mourned by Milton in "Lycidas". You are lucky to get the epitaph of a line of fine print. Because it is not even certain that you were drowned. If your body is not a "floater", it may not even be recovered.

Though man begins his life in the fluid surroundings of the womb, he doesn't easily take to the water. The human being is ill-equipped for floating like plankton or swimming like nekton. Continuous muscular activity is needed to keep the head above water. The inert human body may float in water, but upright with only the smallest area of scalp out of water; the mouth and nose remain submerged.

The buoyancy of the human body also depends on the salinity of the water. About 98 per cent of the population is positively buoyant in sea water and 90 per cent in fresh water. Individual variations in buoyancy depend partly on the constituents of the body. The specific gravity of the human body is in fact slightly greater than that of water. About

72 per cent of the total body weight is accounted for by the water in it. The specific gravity of the remaining 28 per cent is what determines the extent of floating. The lightest part of the human body is fat (specific gravity 0·92); in an average adult, fat is 5 per cent of total weight. Bone is the heaviest constituent, with a specific gravity of 2·01. In the male, the bones weigh about 4·7 kg, and in fact the lightness of the fat and the buoyancy of the lungs is counterbalanced by the weight of the skeleton so that a naked human body when placed in the water has a slight tendency to sink. Women and children have relatively more fat, hence they float more readily. When the whole of the living body is immersed in water, the specific gravity is lowered by the expansion of the chest, and a slight elevating motion of the hands and feet are enough to keep a person on the surface. But the head, owing to the weight of the skull, always tends to sink below the rest of the body.

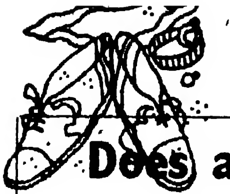


What makes a body float?

A person with a large chest also has a greater tendency to float than a person with a small chest. Air displaces water, and during inspiration the body tends to rise out of water. A person who screams as he falls into the water, empties his lungs and thereby reduces his chances of floating. Clothing may help or retard floating, depending on its nature.

Man, therefore, is not a natural floater. To move and float in water he has to exert himself. In active aquatic creatures — even in the secondary aquatic whales — propulsion is provided by the undulations of the tail. In a human swimmer, propulsion is largely provided by the rotating movements of the arms (though the palms are poor paddles) which also keep the head above the water. The efforts of the legs serve mainly to keep the axis of the body in the direction of locomotion.

Many people cannot swim at all. A good many can swim a length or two in the swimming pool; then a few such as skin divers and pearl divers are at home in the sea. The speed and endurance of the average swimmer is limited. Even an expert is not able to manage more than 2·4 km per hour for a length of time—and this may be offset by tides and currents.



Does a drowning man rise three times?

There is a popular belief that a drowning man rises to the surface three times before he sinks forever. In practice, however, his rising and sinking can be a more extended process. When he falls into the water he sinks to a depth proportional to the momentum of the fall. He rises immediately, owing to his struggling movements and perhaps to the buoyancy of his clothes.

If the man is not a swimmer he cries for help and thereby takes water into his stomach and lungs. The water in the lungs excites coughing; some air is expelled from the lungs, and its place is taken by water. His weight increases and he sinks. He struggles to the surface again, takes in more water and sinks. This goes on till all the air from the lungs is displaced by water and he sinks to the bottom to die. Sometimes convulsions precede death.

Death occurs often within 6 minutes — almost invariably within 10 minutes—of the body becoming totally immersed. Even those recovered from the water while still alive are doomed to die within a few minutes from disastrous biochemical changes which have taken place. In fact, this explains a seldom appreciated fact — the high mortality rate in drowning accidents. Also, whereas in accidents on land, less than one per cent of victims who become unconscious die, an unconscious person in the water will drown unless immediately removed. This is particularly true of those who fall into water after receiving a blow, or who have a fainting attack, or who have heart failure while swimming.

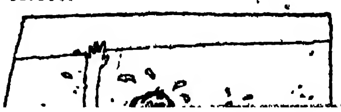
Drowning can take place in shallow water. It is enough if the nose and mouth are submerged for not more than 2·5 cm. This explains cases of drunken persons found dead in pools or ditches.

A sudden immersion in cold water can cause death from what is called reflex cardiac arrest. The physiological basis of reflex cardiac

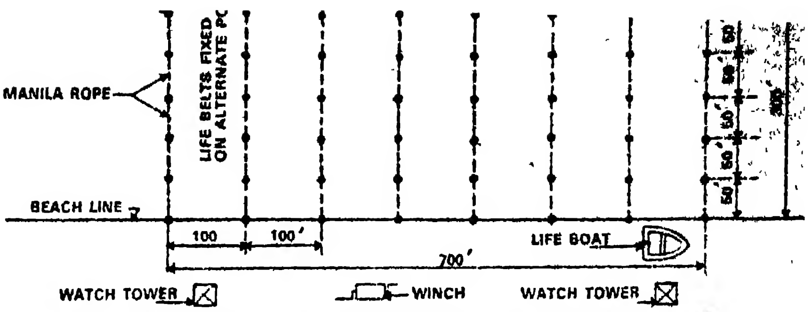
---

Methinks he hath no drowning mark upon him.

—"THE TEMPEST"



The Sea is a Hunter



Bathers at Juhu would have less to fear from the sea if these safety measures, suggested by the Safety First Association, were concretised

EVERY year 140,000 people all over the world get drowned. This works out to 5·6 deaths per 100,000. Japan leads with 9 deaths per 100,000, followed by Australia with 5·5, USA with 4·6 and the UK with 4. In a study of 1,327 drowning cases, the Royal Life Saving Society of UK found that (apart from 290 suicides), 172 cases were children playing near water, 165 swimming, bathing or paddling accidents, 161 from boats, 54 accidents in the home, 34 fishing, 33 under the influence of drink, 26 from vehicles, 23 cases of giddiness and various other minor categories.

To those who live beside the sea—sailors and fishermen — and who indeed make their living from it, a drowning tragedy has a poignancy of its own. But to Authority, a drowning case is a mere statistic. What if a few people get drowned at seaside resorts? Are not so many other kinds of accidents occurring all the time?

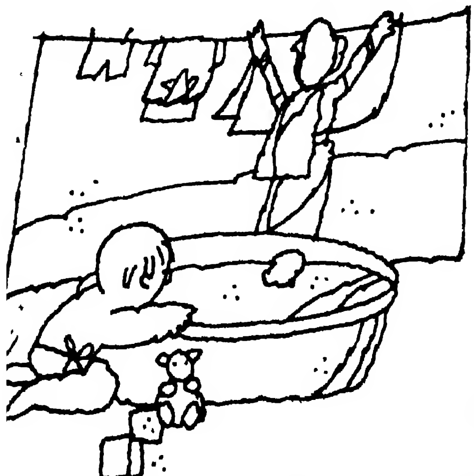
At Juhu, a popular seaside resort of Bombay, for example, nearly 100 people get drowned each year during the monsoon. In addition to the treacherous quicksands, it is suspected that the stinging coelenterates, or blue-bottles (also known as Portuguese Men-of-war), are a cause of deaths attributed to drowning on the coast near Bombay. These creatures which are carried towards the shore along with the current during the hot season have been seen in groups on the crests of waves on Juhu beach. Multiple stings can be fatal, though one or two merely cause nausea and cramps.

About 200 picnickers were stung by blue-bottles at Juhu on 11 June 1972, in spite of the cautionary notices put up by the municipal authorities. The victims were sent to doctors, as there is no provision on the spot for treating the stings.

The precautions against drowning are equally elementary.

In 1954 the Safety First Association submitted to the Bombay Municipal Corporation a scheme to improve and extend the lifeguard service for bathers at Juhu. The scheme included the marking of a "protected area" provided with lifeguards and other services; watch-towers where the lifeguards would be posted during swimming hours; parallel lifelines, made buoyant by life buoys, running about 200 metres into the sea; and first aid service including oxygen cylinders and stretchers.

No progress was made except that in 1969 the Corporation took over the lifeguard service. The scheme submitted by the SFA presumably lies safely in cold storage.



Death in water does not always involve drowning

arrest is as follows (according to Bernard Picton): the carotid arteries have small swellings on them, which are sensitive to changes in pressure. They send messages via the vagus nerve in the neck to the brain and heart to maintain a steady blood-pressure. If they become grossly over-stimulated, as by a punch or sudden cold, they send out explosive nerve impulses which can stop the heart. This is a "reflex", as the vagus nerve impulses flash from the carotid to the brain and back to the heart.

Even if a person falls into water and is pulled out immediately, he may be dead before drowning can occur. This is more common in cold countries. Even water at 7°C will produce rise in blood pressure, and disorders of heart rhythm have been caused by water at 17°C. (In arctic waters death may occur within 15 minutes.) Between 4° and 10°C, a person may expect to survive two hours. The blood vessels

MURDER? • SUICIDE? • ACCIDENT?

He had the undistinguished name of George Joseph Smith. But in the annals of medical jurisprudence, his name will live for long because he thought up the almost perfect murder, making it look like accident. But he gave himself away by repeating his methods. In each case he got his victims to draw up wills in his favour, after marrying them. In each case he had entered the bathroom while the victim was bathing and drowned her without any injuries. During the trial it was demonstrated that it was possible to submerge an unsuspecting person all of a sudden into a bath and to keep his head under water for five or 10 minutes for death to occur without producing any injury. The victim would be unable to offer any resistance as he would become unconscious when water begins rushing through the nose. It is however probable that death in this case was due to reflex cardiac arrest (see page 39) rather than drowning, because the sudden impingement of cold water against the back of the throat or nose is believed to be enough to cause reflex cardiac arrest.

However, homicidal drowning is rare except in the case of infants, drunk persons and children. Commonly, children are robbed of their ornaments, and their bodies then dumped into a tank or well.

Drowning however accounts for a large proportion of accidental deaths. In 1966, of a total of 121,624 accidental deaths in India, 29,576 or 24 per cent were due to drowning. The largest number of drowning deaths (4438) was in Maharashtra. Among cities, Bombay topped with 203 cases.

Drowning, together with hanging and poisoning, is a favourite with the suicide-prone accounting for 25 per cent of such deaths in 1966. The maximum number was in Andhra Pradesh (2420). Among cities, however, Bangalore led with 125. As regards motives, the largest category (2650) was that of persons suffering from incurable diseases.

According to Dr. C. A. Franklin, Police Surgeon of Bombay, about 500 bodies are recovered from water around Bombay each year. The forensic surgeon is often called upon to give evidence whether a person has died of drowning and whether it is a case of suicide, accident or murder. Dr. Franklin says "it is often the habit with criminals to throw their victims into a river or lake, partly in the hope of making it look like suicide and partly in the hope that the body will not be recovered. After remaining in water for some days, decomposition sets in and the signs of violence may even vanish. The police surgeon's evidence is based on certain diagnostic signs."

In a typical death from asphyxia due to drowning, the face of the victim is pale, the eyes half open or closed, the conjunctivae congested and the pupils dilated. There is a fine white froth, sometimes tinged with blood, at the mouth and nostrils. There is similar froth in cases of opium poisoning and in deaths by slow asphyxia, but the froth is not so lasting and is smaller in quantity. The drowning man clutches at a straw, it is said, and in fact, grass, gravel, sticks and weeds may be found firmly clasped in the hands.

The lungs are distended like balloons. On autopsy, the larynx, trachea and bronchial tubes contain fine white froth and also foreign matter like sand or fragments of aquatic plants.

A drowned person has copious fine foam at the mouth and nostrils

of the head, if diseased, as in epileptic persons, may be ruptured by the sudden inrush of blood to the brain, caused by the cold and the exertions.

Drowning accidents which take place during diving are often the result of unconsciousness, brought about by oxygen lack, with drowning as a secondary consequence. Divers often hyperventilate before submerging, in an attempt to remain longer under water. The exertion and heat loss in water increase the oxygen requirement: yet the carbon dioxide level in the arteries is not adequate to stimulate the respiratory centre of the brain. The brain is deprived of oxygen; there is loss of consciousness, and drowning takes place, if the diver has not yet surfaced.

There are a few cases of drowning with choking caused by a spasm set off by a small quantity of water entering the voice-box. Water does not enter the lungs and the other symptoms of drowning are absent. More

In 1942 Incze of Budapest demonstrated the presence of diatoms in the lungs and other organs where they had been deposited from the water absorbed. Diatoms are small plants composed of silica, which resist decomposition and can be extracted by dissolving the tissues in acids or ferments. This technique is useful in investigating decomposed cases where the signs of drowning are poorly developed.

If the Germans had used this technique to investigate the case of "Major Martin", they would have been wiser about the intentions of the Allies. Here a "drowned" body carrying false documents was planted in the sea off the coast of Spain by the Allies in 1943 and this successfully caused the diversion of many German troops from the actual site of the Allied landing in Sicily.

Alexander C. Gettler suggested the determination of the chloride contents in the blood of the right and left chambers of the heart as a specific test for drowning. Normally the chloride contents are almost the same, but in salt water drowning the left chamber showed higher chloride content; in fresh water drowning it showed lower chloride content. But this method has the limitation that the samples of blood must be collected within an hour. (Quoted in "Modi's Medical Jurisprudence".)

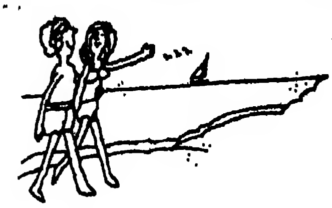
Dr. Franklin considers that the presence of mud and sand in the small intestine beyond the stomach is positive evidence of death by drowning (and not by other means) because in the living body there is peristaltic movement of the intestine. If the body has been thrown into the water after death, the peristaltic movement would have ceased earlier.

The diatom test, Dr. Franklin feels, is helpful in cases where the body has been shifted from one spot to another, because the kind and proportions of the diatoms in water vary with the location.

water is swallowed than inhaled. This reduces the urgency to inhale, so that complete respiratory paralysis occurs before water can enter the lungs. Victims, when they recover, vomit large quantities of water. Such cases of "dry drowning" offer the best chances of resuscitation.

What happens in the majority of cases is that water enters the lungs and gets mixed up with air and mucus to produce a fine froth which blocks up the air vesicles. However, death is

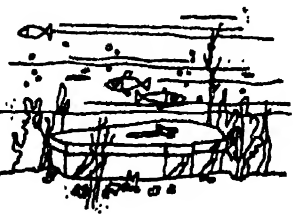
Nor is drowning death, simple asphyxia



not due to simple asphyxia. The exact events preceding death depend on whether drowning occurs in fresh water or salt water. In either case, a thin permeable membrane, many hundreds of square metres in area, separates the blood plasma from the water. The blood on one side of the membrane has a high osmotic pressure due to salts and other chemicals. When fresh water is taken in into the lungs, there is a sudden increase in blood volume. The heart is unable to deal with the extra fluid. If death does not take place at this stage by heart failure, the red blood cells burst their envelopes, being unable to resist the sudden change in osmotic pressure. Potassium from the red blood cells is released in bulk into the blood plasma, and this together with oxygen deprivation and carbon dioxide accumulation, complete the biochemical catastrophe. A fine froth is found in the lungs on post-mortem examination.

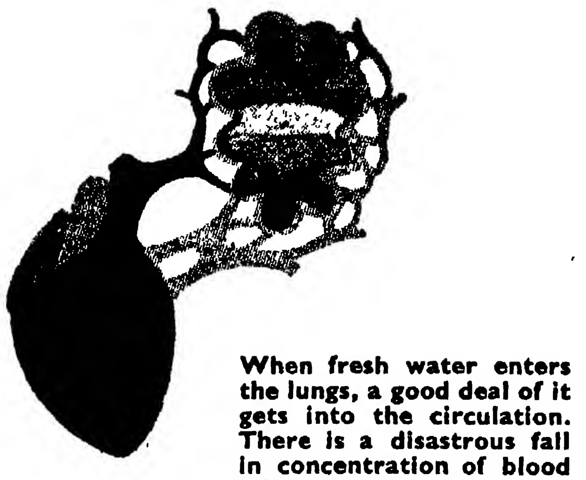
Sea water contains 3·5 per cent salt. In sea water drowning, a smaller quantity of fluid is drawn from the blood through the lung membranes. There is some shrinkage of red blood cells and a concentration of blood owing to the rise in the sodium chloride content. Death occurs from failure of the heart muscle due to lack of oxygen. The lungs, by way of a defensive reaction against the sea water, produce a protein exudate which enters the air sacs or alveoli, where with the air and water it produces a fine froth.

One popular belief has it that a drowning man has a panoramic view of the events of his life in his final moments. Of course, our only



What are the thoughts of a drowning man?

WHAT HAPPENS IN FRESH WATER



When fresh water enters the lungs, a good deal of it gets into the circulation. There is a disastrous fall in concentration of blood salts and proteins

...AND IN SEA WATER

Sea water has a much higher osmotic pressure than blood, hence when it is inhaled, fluid is withdrawn from the blood into the lungs. The result is a concentration of blood

source of information are those who have recovered from drowning. In the case of a female reported in 1894, and quoted by D. C. Rushton in the *Medico-legal Journal*, self-preservation was the only thought. "I sank and gasped involuntarily, then all other senses were overpowered by the agonising scorching pain which followed the rush of salt water into my lungs. From that moment I was conscious only of that burning suffocation and the intense desire that others might know what had become of me." She was unconscious when rescued by her husband within 3 minutes of being submerged. A boy of 15 years who was rescued from drowning said that whilst under water he had "a terrible dream that he was on a train going to Heaven".

Death generally occurs within 6 minutes of becoming completely immersed. Hence prompt rescue before large quantities of water are inhaled is a factor which contributes towards recovery. Prospects of survival also depend on the fitness of the subject. A person with heart disease may die from sudden shock the moment he falls into cold water ; such persons may be found dead in their own domestic baths.

A drowned person will sink, especially if he has little clothing on his body. After some time, it will rise, depending on its specific gravity and the nature of the water (whether salt or fresh).

When large quantities of water have been inhaled it is most unlikely that recovery will occur, though the heart may continue to beat ineffectively for several minutes after rescue. The time required to inhale lethal amounts of fluid is very small — especially in fresh water, where ventricular fibrillation may commence 2 minutes after beginning to breathe water. The time available for rescue, and resuscitation is short for those who have passed the phase of laryngeal spasm and have inhaled large amounts of water.

Even in the case of those who have inhaled little water — and there is no quick method of deciding how much water has been inhaled — there is no time to be lost.

Exhaled air resuscitation or mouth to mouth respiration should be given as soon as the victim is brought ashore (or even in shallow water). Loosening of clothing, checking the position of the tongue, and clearing of water from air passage are matters that can wait. Revival measures should be taken even when circulation and respiration have failed. Most doctors agree that 15 minutes artificial respiration should be given, before any examination is made, and that this process be continued for at least *one hour* before attempts are abandoned. If after half a dozen inhalations, no pulse can be felt in the neck and if the pupils of the eye are dilated, closed chest cardiac massage should be given. These two measures will revive and keep circulation and respiration going till the victim reaches a hospital.

But ere we could arrive the point propos'd,
Caesar cried 'Help me, Cassius, or I sink !'

— "JULIUS CAESAR"

The " kiss of life " or direct mouth-to-mouth method of artificial respir

It must be emphasised that hospitalisation should be a routine measure in drowning cases, because " secondary drowning " can occur even in apparently recovered cases.

Artificial respiration can be either by the Holgen-Neilson method or the Schafer method (see below). The former is a push-pull method. Pressure is applied to the upper chest to induce expiration and the arms are lifted with a rocking movement to induce inspiration. The direct inflation (mouth-to-mouth method) is considered superior by some.

After the patient has begun breathing, he should be covered with warm blankets and given a little brandy in warm water or milk, if he can swallow it. But he is not yet out of the woods. For some days he should be watched for complications. In fresh water drowning, there may be kidney damage due to destruction of red cells and staining of urine with red blood pigment. Cardiac failure due to withdrawal of fluid from circulation (in salt water cases) can occur even when the patient appears to be on the mend. The inhalation of large quantities of dirty and infected water can cause pneumonia.

Dos and don'ts for swimmers

The best way of coming to terms with water is to learn swimming. In Australia 75 per cent of the population live within reach of the sea, and there it is the boast of parents that a child learns to swim before it learns to walk. It is not enough if a person is able to swim a couple of lengths. A nation-wide " learn to swim " campaign can do a lot for water safety at a time when water sports are becoming more and more popular.

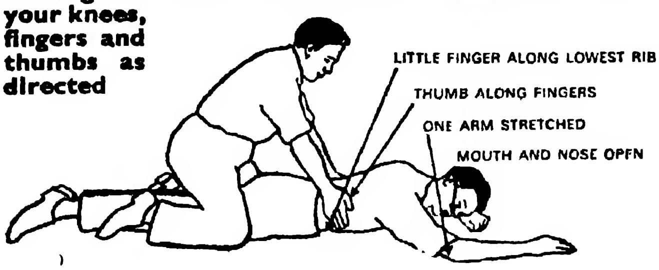
At pleasure resorts along the coast where owing to the crowding the accident rate is likely to be higher, as well as in particularly dangerous spots, authority can step in to provide safety to bathers by cordoning off dangerous zones and maintaining a rescue system.

Then there are some common-sense precautions for swimmers. It is foolish to bathe if even only slightly intoxicated. It is unwise to swim alone or to take a " star-light dip". Don't go out of your depth if you have a disability or proneness to cramp, don't swim

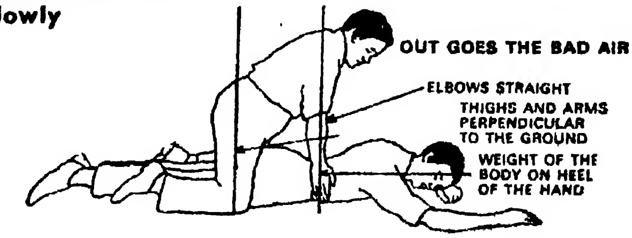
ARTIFICIAL RESPIRATION (SCHAFER'S PRONE PRESSURE METHOD)

Even if the victim appears dead, remove him from water quickly and place on ground. If possible, have the head slightly lower than rest of body to drain away water from the victim. Then proceed to give artificial respiration as detailed in steps No. 1, 2 and 3

1. Lay the victim on the belly following the directions given below. Kneel astride the victim with your knees, fingers and thumbs as directed

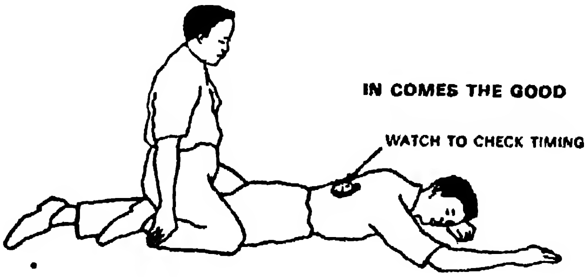


2. Swing forward slowly so as to bring the of your body to bear on the small of the victim's back. Say " out goes the bad air" slowly



3. Now swing back with a *quick release* of the pressure. Say " In comes the good "

[*Courtesy:* SAFETY FIRST ASSOCIATION OF INDIA]



4. Pause and then swing forward and repeat expiration as in 2 and 3. Expiration and inspiration should together take about five seconds. Continue till patient breathes normally or till a doctor certifies that *rigor mortis* has set in

TAKE A DEEP BREATH . .. OF WATER

Why is it that a lung-breather cannot "breathe" water? For one thing, natural waters have a different composition from that of blood. They also contain too little dissolved oxygen to meet the requirements of high-energy metabolisers like mammals.

In 1961, Prof. Johannes A. Kylstra of the Duke University Medical Centre (USA) conducted experiments in which mice were submerged in a solution similar to blood in composition and enriched with oxygen. Some of them survived several hours. The limiting factor was not oxygen but the elimination of the exhaled carbon dioxide. A solution with a composition approximately like that of blood holds only about half the quantity of carbon dioxide as the exhaled air of a mammal. Also, water is about 36 times more viscous than air, and a proportionately greater force is required to inhale and exhale it. In later experiments with dogs, which were immersed for three-fourths of an hour in a chamber pressurised with air at five atmospheres, the gas content of the liquid inhaled and exhaled was measured; the carbon dioxide content of the blood was found enhanced, indicating that its elimination was faulty.

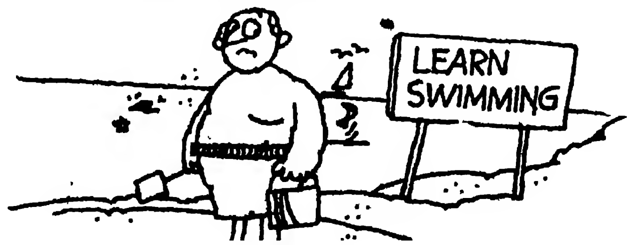
Essentially, the difference between a gill and a lung is a matter of geometry. The lung's basic units are some 500,000 air-sacs. Oxygen diffuses rapidly in air and is distributed to the entire air-sac in milliseconds. In water the respiratory gases diffuse about 6,000 times more slowly than in air.

Research on water-breathing has a significance for a problem experienced by deep-sea divers. During the sudden decompression caused by a rapid return to the surface, the gases dissolved in the blood are released as bubbles and cause what is known as "bends" or caisson sickness. Bends can be prevented by having the diver breathe a suitable enriched liquid instead of air; the liquid in his lungs would resist the external pressure without changing significantly in volume. Multiple *g* forces experienced by space travellers during acceleration could also be made tolerable if the lungs were filled with water instead of air and the body suspended in a fluid having the density of blood. However, the slow rate of expiration of fluid from the lungs is likely to be a major hurdle.

when tired or after food; don't dive into unfamiliar waters. Better swim parallel to the shore than away from it. Beware of swimming to an anchored boat or across a river, because the boat or bank will be farther off than it seems; if the water is fresh it will be very cold and you will soon be exhausted. Even while swimming parallel to the shore, watch some shore land-marks to make sure that you are not being carried away by the current.

Even if you come close to drowning, the important thing is not to panic. Remember what we said earlier about 98 per cent of the population being "floaters" in sea water? Even if you don't know swimming you can keep afloat by a survival technique called "drowning proofing", an idea of Fred Lanoue, an American Professor of Physical Education. If there is air in your lungs and you have not swallowed too much water, you will float in the upright position. The trick is to breathe when the mouth and nose are clear of water. This is no substitute for knowing swimming, but merely an accessory.

"What do they take me for—a fish?"



PRAVIN KUMAR is Chief Sub-editor of SCIENCE TODAY.

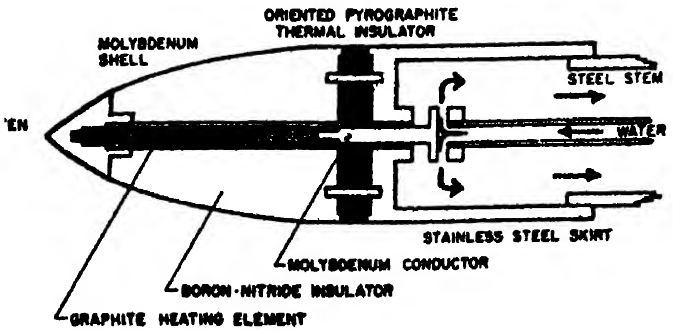
[SKETCHES BY SABIR]

Tunnel-digger cuts cost and risks

A TUNNEL-DIGGER which can cut its way through rock " like a hot knife through butter " could be of immense value in a vast country like India. Work on a 446-metre-long tunnel through the Malabar Hill in Bombay, part of a multi-crore road development plan, will start soon after the monsoon. It is proposed to cut two parallel tunnels, each about 9 metres wide, for traffic in either direction. The project is estimated to cost about Rs. 11 crores.

Not only roads, but several important infrastructures such as laying of water or oil pipes through hills, mining and ventilation ducts in mines, etc need tunnelling. The tunnelling technology, however, is still based on laborious, time-consuming, and often dangerous, operations like mechanical drilling, controlled dynamite blasts, concrete lining etc. Clearing the debris is still a major problem. Besides time and money, the operations can also cost in life if the tunnel caves in during construction. A major portion of the Malabar Hill tunnel will pass through a homogenous basalt zone, needing no protective lining but one-third of the tunnel through sedimentary rocks will be lined with concrete to prevent the rocks from weathering.

A new tunnel-digger being developed at the Los Alamos Scientific Laboratory in Los Alamos, USA, promises to eliminate these hazards and make the operation simple. Rocks generally melt at 1,200°C. The new tunnel-digger uses electrical heat and pressure to melt and penetrate through the rocks. The unit has three main components — a penetrator, a heating element and a coolant or radiator. The tip of the unit, the penetrator made of a refractory metal (tungsten in this case), is heated by the heating element, which is surrounded by an insulator (see sketch). At the other end of the unit is the coolant, working on water or gas circulation. The coolant is again shielded in front by an insulator (pyrographite thermal insulator in the prototype). This is the basic operation. It can be modified according to requirements. For instance, the penetrator could be given different shapes, flat or circular, depending on the type of tunnel needed. A wall-grabber will help propel the unit along the wall.



The prototype at Alamos has a 5-cm borer. On a power supply of 3 kilowatts an hour, it can dig a 75-cm-deep hole in an hour. By increasing the size of the borer and the power supply to 10 to 50 megawatts, a 10·7-metre-wide tunnel can be dug at the rate of 90 metres a day. Eventually, nuclear reactors can provide this power. But that will take another decade of development.

In operation, the heated tip melts the rock on contact. More important, it forces the molten rock into open gaps in the tunnel wall and the cool surface of the radiator, following immediately after, freezes the molten rock in place to form a glass-like wall lining. The process also eliminates debris removal.

Fast reactor

AN experimental, zero-energy fast reactor core has been set up at the Bhabha Atomic Research Centre, Trombay. The core went critical in May. Basically, the unit is an instrument to study the nuclear behaviour of the core of a pulsed-fast reactor, an experimental reactor for basic research, being set up at the Reactor Research Centre, Madras. When completed, the pulsed-fast reactor will be the second such reactor in the world. The first one has been in existence at Dubna, USSR, for the last eight years.

In a fast reactor, unlike in conventional nuclear reactors, the neutrons from the chain reaction are not slowed down using moderators. And in a pulsed-fast reactor fast neutrons are obtained in pulses. The reactor will be used to conduct basic studies in solid state physics, radiation damage and the measurement of neutron cross-sections. Using the zero-energy facility at Trombay, scientists will study nuclear parameters which will help them to design the reflector and control systems of the pulsed-fast reactor core which uses plutonium oxide

(Contd. on page 58)

SOME authorities contend that we now know more about the surface of the Moon than we do about our own oceans. I've certainly found this to be true with the elementary school youngsters that I teach. Take these comments from a recent quiz:

" In looking at a drop of ocean water under a microscope, we find there are twice as many H's as O's."

" Here is something of an else. If water from the ocean is mixed with vapour it is lighter than air. It's the oddest truth."

Confusion seems to take over completely when the small ones centre their attention on the subject of ocean inhabitants, e.g.:

" You should always capitalise the word whale unless it is not the first word in the sentence."

" The Scorpion was the pioneer of all the land animals. I think history will decide he is just as important as Columbus."

" When I learned we were going to see a film about how the oceans got started, I told my feet to quiet down but they felt too Saturday to listen."

The fun comes when a child scores a near miss on the target of knowledge and comes up with a genuine blooper such as this one: " Compared with the ocean, people have been living on the earth for only a drop in the bucket."

Sometimes the confusion is so deep they just admit they don't know — but that doesn't keep their answers from being charming:

" The oceans have been here since 600 million but I forget whether it was A.C. or D.C."

young scientists tackle mysteries of the deep

HAROLD DUNN

Last year a bright-eyed little economist came up with this one: " If the shoreline of Maine was straightened out, it would reach to Mexico. But we must cut government spending somewhere."

History may repeat itself but nine-year-olds can usually add some unexpected twists to it. Here are some historical " facts " that you probably never suspected:

" The oceans were formed about 600 million years ago. 600 million is bigger than the largest known whale."

" Most authorities think that sea life of antiquity lived long ago."

" While fish in the ocean were just playing around and having a good time, man was hard at work thinking how to evolve."

" I looked up what a coral atoll is twice but I forgot at three times."

" I am unsure how sea spiders can manage to live at the bottom of the ocean. Maybe you can explain it to me. I can't."

IF you're at all hazy about crustaceans, hang on. These next thoughts will leave you only slightly worse off than before:

" Crustacean is a many-purposed word for many ocean-types."

" Will crustaceans be able to live in the ocean much longer if we keep on doing like we are doing? The chances are 999 out of hundred."

" Another name for crab is crustacean, but I think I will just stick with the first word and learn it good."

Here's another highly imaginative idea that might never occur to a grownup: " Crustacean means you can wear your bones on the outside."

" If I should say CURRENT, what I mean would depend on if I said it in history class or under water."

EVEN when I think the kids understand something perfectly and there aren't any questions, I sometimes discover that something is lurking underneath — something called total confusion. Their fund of knowledge about divers includes such fascinating items as these:

" So far, divers have only been able to swim around in circles with no more than 360 degrees. This could be the next big breakthrough in diving."

" If I was a diver, the part of the ocean I would like best is where the top is closest to the bottom."

" When divers come up they have to be careful to have decompression. Decompression is easier to say than to tell what it means."

Anyone who has listened to kids knows that these moments can be full of surprises and intimate glimpses into what is really going on in a child's mind. Much of the fun in talking to them comes from the startling way they can put a backspin on their answers, saying something that's ridiculous and sensible at the same time. Here's what I mean:

" One time I was standing on a beach of the Pacific Ocean when a huge wave came at me. I was so scared my heart beat all the rest of that day."

" A shark is a fish. You can tell by feeling its gills if you really want to know that bad."

" What sailors say about oceans is much saltier than about rivers."

" At the North Pole and the South Pole the ocean grows ice."

CHILDREN are completely natural (and a little confused) when they turn their attention to scientific observations about the ocean. Here are four of my favourites:

" Many things about the ocean that were once thought to be science fiction now actually are."

" I haven't worked out how to change salt water into fresh water yet, but I will do it over the weekend."

" It will take much hard work to get our oceans like they should be. It is something we should keep thinking about around the clock, twelve days a week."

" California will be completely under the ocean in a few million years. Just wait and see."

HERE'S one that ends with the finality of dropped egg: " What I have to say about oceans is they take up too much room! they are too big for their own good! THE END!"

You can't argue with this young writer. When she's through, she stops writing — which is good example for grownups to follow.

[Harold Dunn is a school-teacher from Kirkwood, Montana, USA. We had earlier published two such collections of his on the amusing malapropisms of youngsters in the science class.]

household horrors—1

Concerning the Cockroach

R. N. SHARMA and K. N. SAXENA

"Blatella germanica" or the German cockroach

"Periplaneta americana," the American cockroach

AS you enter your kitchen, most likely a few brownish cockroaches which have been feasting on food left-overs will scurry away with almost lightning speed. You may not give much more thought to them beyond reaching for your Flit sprayer.

Actually, these repulsive creatures are hot favourites with researchers. Their unspecialised structure makes them ideal material for a great variety of researches. They might even help us find out how insects develop resistance to insecticides, because cockroaches have been coming up with resistant breeds almost as fast as chemists are able to develop insecticides.

The word " cockroach " is derived from the Spanish Cucaracha (Cuco meaning " bug "). Cockroaches are found all over the world, 3,500 species having been described. In India the most common household forms are the German roach *Blattella germanica* (2·2 cm long), the Oriental cockroach *Blatta orientalis* and the large American cockroach *Periplaneta americana* (4·5 cm long) (see **Science Today** July 1968). Other indigenous species include *P. australasiae* and *Stilopyga rhombifolia*.

Cockroaches may be found in fields, plantations, orchards, caves, burrows, deserts and even water. Forty-nine domiciliary species of cockroaches have been described. These are invariably denizens of dark, damp and squalid nooks and corners of kitchens, larders, latrines, sewers and other such niches in human habitations. Their favourite haunts are under drainboards, sinks and cupboards. They rest during the day and become active only in the dark, making forages into kitchens, refrigerators and larders at night. Keeping up with the times, one of them (*Supella supellectlium*) has taken to living inside television sets in the USA where it has been aptly nicknamed the TV roach.

"Blatta orientalis", the Oriental cockroach. Female with ootheca. The female is wingless in this form

A female "Periplarieta australasiae" with ootheca (Adapted from Cornell, 1968)

Cockroaches are ravenous gluttons that will take a bite of anything, but are especially partial to sugary or starchy titbits. This " sweet tooth " makes them a menace to bread, fruits, grains and grainbags, even books and clothing whose lining may contain glue or starch. Powerful mandibles or jaws in the mouth and an efficient " grinding mill " consisting of cuticular teeth in the gizzard (pharynx) enable them to partake of a widely variegated menu. Many feed exclusively on plant material and may damage greenhouse plants by eating roots and blossoms. They are seldom a great menace to agriculture except when the organic detritus of the soil is exhausted and the roaches living in fields are forced to turn exclusively to plants for their sustenance. Some cockroaches may prey on ants, larvae of wasps, centipedes, termites, bugs, mosquitoes and eggs of reptiles. Overcrowding, food shortage or excessive heat may even cause them to attack and eat their own kind, especially the recently moulted nymphs and copulating or injured adults.

[CONTINUED]

Cockroaches secrete what are known as aggregation pheromones from glands on the back. These cause the roaches to aggregate in particular areas, and save them the trouble of seeking a mate. In aggregation of roaches shown here, various stages of the life cycle can be seen

A. (Inset): Ootheca or egg case in which a cockroach starts life along with 18-28 others.

B. Cockroach larvae of different ages. These resemble the adult except for smaller size and absence of wings. They cast skin or moult a dozen times before acquiring wings and becoming adults.

C. A full-fledged adult. Adults live for a year (Adapted from Stanek, 1969)

DO COCKROACHES CAUSE DISEASE? Four strains of poliomyelitis virus, 40 species of disease-causing bacteria and 12 helminth (flatworms) species affecting man have been reported from cockroaches, but invariably in such low counts that it is doubtful if the roaches can be seriously implicated in the transmission of any specific human malady. Their indiscriminate forages into garbage and kitchens where they defile the food with saliva and excrement are, however, decidedly unhealthy and unhygienic. Hence, apart from being symbols of neglect and uncleanliness, and arousing distress, fear, hostility and nausea, the cockroaches can hardly be classified as serious pests of either medical or economic importance to Man.

A cockroach (P. americana) starts life in a cigar-shaped egg along with 18-28 others in a small, squarish packet or ootheca. These packets are deposited in cupboards, grainbags, cardboard or wood in a hollow scraped out by the female which also provides a sticky secretion from the mouth for adhesion and covers them with debris. Some 40 days later, the young emerge, bursting open the egg cases at the seams. The egg membranes are eaten by the young. The latter resemble the adult except in small size and absence of wings. They cast skin or moult about a dozen times in as many months before acquiring wings and becoming adults which then live for another year.

COURTSHIP: The young adults are ready to mate in just three to five days. The females secrete a sex-pheromone (a chemical messenger) which wildly excites the males, who flutter their wings and start frantically jostling and probing other roaches with their feelers. Acquiescient females now signal their "acceptance" by secreting another chemical from their feelers. The male then lures the female by exposing glands on his back whose secretions are so attractive to the female that she starts licking them and while she is so preoccupied, the male grasps her genitalia and turns to assume the characteristic back-to-back cockroach copulation stance. The consummation of the act takes one hour and ends with the male depositing a spermatophore (packet containing sperms) in the female. More matings may take place but one is sufficient for the production

Male device for luring females. Abdomen of an adult male cockroach showing the location of the dorsal glands

The dorsal abdominal glands magnified. Secretions from these glands are highly attractive to the female cockroaches (Adapted from Cornell, 1968)

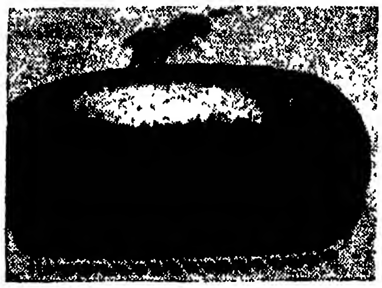
Special defensive secretions may be thrown off by the roaches to ward off enemies. Ants attacking an immobilised roach

Ants have been driven away by defensive secretions from the immobilised victim's back (Adapted from Guthrie and Tindall, 1968)

A Cockroach's Life Isn't Too Easy

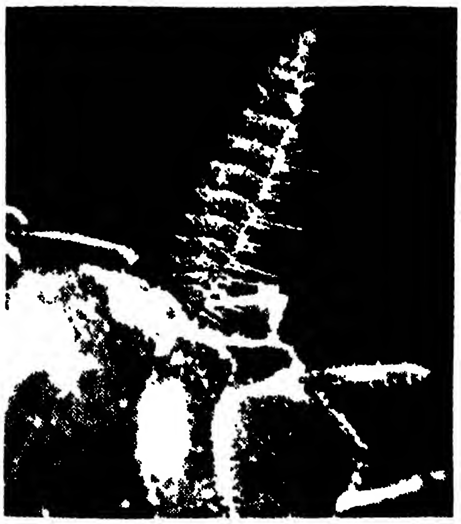
Lizards, spiders, centipedes and millipedes are serious predators of cockroaches both in houses and in the wilds. Rats and frogs also frequently supplement their diet with a "roach meal". The blood sucking Heteropteran bugs may also attack cockroaches. A species of carpet beetle and some wasps parasitize their eggs. Ants and mites may also kill debilitated and injured cockroaches. Though more than a hundred species of bacteria, viruses, fungi and protozoa have been reported from the cockroaches, only a few bacteria and fungi cause diseases in the cockroach.

Of the various defences of the cockroaches against their enemies, the most notable is their "escape reaction" — the familiar scurrying away of the cockroach upon the slightest disturbance. Special nervous circuits consisting of large giant axons or nerve fibres geared for fast action aid the cockroach in this. Measured with an oscilloscope, it takes only 20 milliseconds for the cockroach nervous system to react to stimulation. Flying and diving, as also protective coloration or mimicry, are other evasive devices. Generally, all cockroaches have an acrid smell due to secretions produced by abdominal or tracheal glands. In some (e g *Eurycotis floridana, Diploptera punctata*) this chemical defence mechanism has been carried to perfection: the secretions of these cockroaches contain various irritant chemicals which can effectively deter toads, frogs, lizards, spiders and ants.



Cockroaches have their natural enemies. Some wasps are capable of developing to adulthood on the eggs of cockroaches. Females of such wasps lay their eggs in oothecae. An adult wasp emerging from an ootheca it had parasitised

Another wasp laying eggs in ootheca of cockroach (Adapted from Cornell)



The cercus of an adult cockroach showing various receptor organs and hairs. These are responsible for the "escape reaction" — the familiar scurrying away of cockroaches on the slightest disturbance. It takes only 54 milliseconds (a millisecond = 1/1000 second) for a cockroach to be startled and sent scampering away

(Adapted from Cornell, 1968)

of the 40 oothecae, or so, that a female produces at the rate of one per week till she dies. In India, cockroaches breed from March to September.

REDUCING ROACH RAIDS: There are various methods of getting rid of cockroaches. The prime requisite is cleanliness, good housekeeping and hygiene. Quick disposal of scraps of food and kitchen waste definitely reduce roach raids on houses. The effectiveness of mechanical traps (a few have recently become available in Indian markets) can be greatly enhanced by using baits such as peels or pieces of banana, apple and orange. Best of all is stale beer! Powerful poisons such as DDT, BHC, Dieldrin, Diazinon, Malathion, Pyrethrum are also available under various trade names with special formulations for killing roaches. Lacquers containing Pyrethrum painted on walls, pipes, drains etc., remain lethal for an year. Recently techniques have been evolved in which insecticides are incorporated in special absorbent strips from which the toxicants emit slowly and successfully control roaches. Heavy infestation of large buildings may be eradicated by fumigation with hydrogen cyanide or sulphur dioxide or superheated steam.

RESISTANCE TO POISONS: Coming from a sturdy stock, the roaches have taken much of man's aggression in their stride. They have come up with resistance — that is, an ability to survive the toxic action of the poisons used against them. Many do get killed initially but a few are able to survive by virtue of some biochemical or physiological defence stratagem. These survivors then breed their own kind to give rise to resistant populations which are immune to the toxicants which were earlier so lethal. Thus, resistant cockroaches by means of enzymes convert DDT to a harmless substance DDE and so escape toxication by this powerful insecticide. New and alternative chemicals must then be used.

The large size of the cockroach, coupled with its typical unspecialised insect anatomy has always made it an object of man's curiosity. Not only are thousands of cockroaches laid on dissecting tables of biology students the world over, but they are also used quite extensively in research.

Cockroaches have contributed much to our understanding of various phenomena and in the process much has been learnt about them too. No more than a passing reference can be made to important researches with cockroaches on such aspects as their behaviour, nervous and digestive physiology, internal biochemistry, general metabolism and hormonal mechanisms, not to mention extensive investigations undertaken to discover ways and means by which these animals become resistant to highly potent toxins. Suffice it to say that the humble cockroach has contributed in no small measure to the advancement of human knowledge and is likely to continue doing so, along with, of course, its other, less endearing activities.

K. N. SAXENA is Professor of Zoology at the University of Delhi, where he and his team are working on various aspects of insect physiology. He has worked with various laboratories abroad.

R. N. SHARMA is working with Prof. Saxena's group on problems of insect behaviour and pest control by non-insecticidal methods.

ideas & inventions

HEAD-GEAR FOR HEROES

ARE steel helmets the best protection against bullets? A light-weight alternative, which is claimed to be more effective is now available.

The imported steel helmets now being used by the Indian armed forces seem to be on the way out. Before long our *jawans* may be using new bullet-proof helmets made of fibreglass reinforced plastics. Invented and developed by Mr. Josef Nejedly of Praga Industries Pvt. Ltd., Coimbatore, these helmets are light in weight, comfortable to wear and possess all the qualities of the conventional steel helmets.

The new helmet is made by first preparing specially woven patterns from selected gauges of fibreglass, blending with polyester resin, and subjecting to high compression in a hydraulic press. The anti-ballistic qualities of the helmet are achieved by ensuring correct glass-to-resin ratio, precise control of temperature and pressure during compression, and by employing the right type of fibreglass reinforcement. The inner cushioning cradle of the helmet is made of web-cotton and is firmly fastened to the shell body. A detachable leather head-band around the perimeter of the shell body is fixed to the base of the web framework by means of metal clips. The head-band can be adjusted for size. The rim of the shell is provided with a special rubber beading.

Due to the low thermal conductivity of glass reinforced plastics, the new helmet has very good thermal insulation properties and affords protection from both cold and hot extremes. The shell being of rigid laminate construction, the helmet does not stretch or buckle. The whole material is so structured that on missile impact the force is dissipated in outward directions. In the case of the steel helmet, the major portion of the impact force is dissipated at the point of impact, often resulting in fatal injuries.

The technology involved in making the helmet can also be adapted for producing other forms of head-gear, such as tank-crew and parachute-crew helmets.

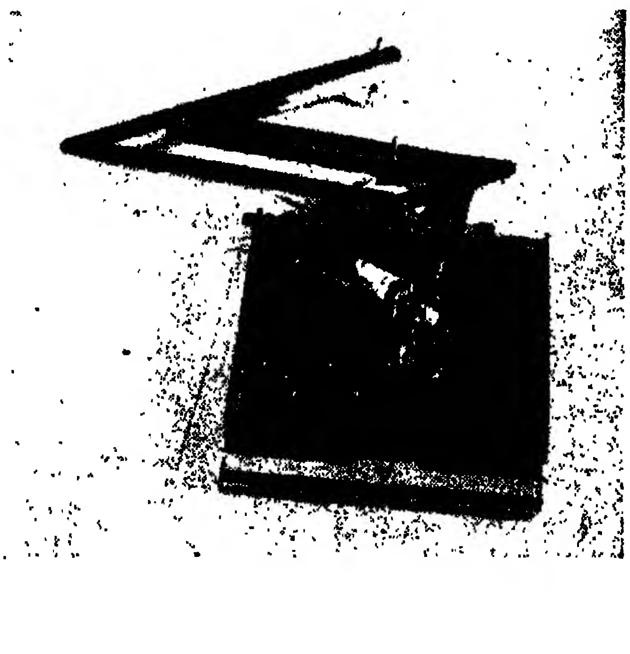
... missile's force is dissipated outwards

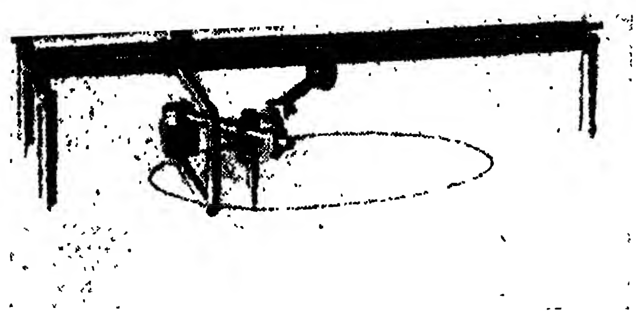
IT'S EASY TO DRAW ELLIPSES

DRAWING ellipses need no longer be a headache to artists, draftsmen and architects. Three Indian inventors have come up with three different ingenious devices to do the job quickly and accurately.

The first elliptograph developed is the invention of Mr. B. P. Mitra, a Traffic Inspector at Aurangabad in Maharashtra. His device is based on the principle of relative motion in uniform time. In actual practice, circular motions of two discs are changed into linear motions by means of appropriate sliders and

B. P. Mitra's elliptograph ... swift, easy and accurate





Ajoy Kumar Ghosh's ellipse tracer . . . draws ellipses, coupler curves and combined curves and straight lines

sub-sliders. These linear motions (of two different directions) are merged to form elliptical motions by means of a collapsible arm that carries a pencil or pen to draw the required ellipses. Mr. Mitra has built up an elaborate mechanism to ensure easy, swift and accurate operation of his device.

Mr. V. Thiagarajan, a draftsman from Madras, has designed a simple device, which draws ellipses from circular holes on an inclined plane by projecting it on a horizontal plane. In his device a light frame that can be clamped at any inclined position is supported on two pillars fixed on a base. The frame has a recess in which templates having circular holes of different sizes can be held in position by means of a screw. For drawing ellipses, the hole of a template is suitably positioned along the major and minor axes and a pencil secured to the clamping instrument is moved around it.

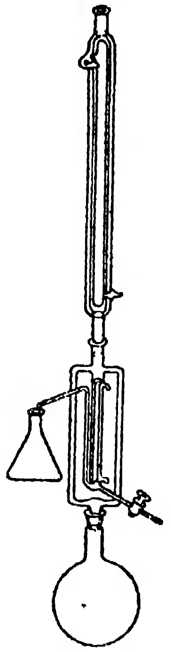
The latest and probably the most sophisticated instrument in this series is the one invented by Mr. Ajoy Kumar Ghosh, an engineering student of Allahabad. His ellipse tracer is easy to operate and manipulate. Its underlying principle is the same as that of the slider crank mechanism. It basically comprises a guide supported on three legs, a slider, a crank and connecting rod, and a tracer carrying a pencil. The crank is fixed between the guide rods by a crank pin. The connecting rod and the slider are connected by an elbow, while the crank and the connecting rod are joined by a hinge. A scale on the connecting rod helps in fixing the major and minor axes of the ellipse.

Mr. Ghosh's instrument is so designed that the locus of any point on the connecting rod is an ellipse when the lengths of both the crank and the connecting rod are equal. When the major and minor axes are fixed, the slider is simply moved from one end of the guide to the other, and the tracer carves out the required ellipse.

A NEW AID IN ATTAR-MAKING

SMALL-SCALE manufacturers of attar and perfumed water should be able to smell out the good points of the distillation flask invented recently by scientists of the National Botanic Gardens, Lucknow. This simple but efficient apparatus may well put the cumbersome *Deg* technique on the shelf.

The main drawback of the *Deg* technique which is extensively used for water distillation of flowers and seeds, is the overheating of the plant material, leading to deterioration in quality of the resultant products. The condensation of the perfumed vapours is rather faulty and there is always some loss due to leakage. Separation of oil from the perfumed water is a major difficulty.



The new apparatus has been designed by Dr. A. Singh, Mr. V. Chandra and Dr. L. D. Kapoor. It is so constructed that the separation of oil and the collection of the perfumed water is automatic. Its double cooling system allows proper condensation of vapours, and as there is no danger of charring the plant material, the quality of the products obtained is much superior.

The device comprises a distillation flask of desired capacity, the main body consisting of a system of tubes, and a condenser, all interconnected one above the other through joints. The main body has two side limbs through which the vapours from the flask pass to the condenser. After condensation, the distillate drips down into a graduated tube in the main body, where it is collected and cooled and the oil separated from the water. The excess perfumed water stored in the graduated tube is automatically siphoned off to a jacketted receiver.

Especially suited for small-scale manufacturers of *attar* and perfumed water, this handy device can be made of pyrex glass, copper or stainless steel. Being scientifically designed, it gives accurate content of the essential oil present in the plant materials, even with very small amounts.

Badiuddin Khan

books

O. R.

Operations Research and the Social Sciences Ed. by J. R. Lawrence (Tavistock Publications, London, 1966; £1.90).

THE past two decades have seen a noteworthy set of transitions: economics into econometrics, psychology into psychometrics, sociology into sociometrics. The metrification, or quantification, of disciplines has now become such a fad that many scientists who aspire to become the 'father' of a new discipline start by suffixing a well known discipline by adding his own 'trics' to it. We Indians are not slow in this game either. Recently a Delhi scientist claimed that he had discovered a new science: Diplometrics. Even a casual examination of these claims will show that all these so-called new disciplines are simply applications of Operations Research to corresponding old disciplines. It is indeed very gratifying to note that the editor preferred the honest to goodness approach for labelling his book.

The essential themes of the book are organisation and control, social effects of policies, conflict resolution, and the systems framework — all apparently with sociological overtones. The editor must have been over-anxious to maximise the thickness of the book (it stands at 669 pages) as is betrayed by the inclusion of articles completely out of tune with the title of the volume. For example, the articles by Wade P. Sewell on the optimal capacity of Air Transport Fleets is a routine OR problem with no relevant sociological implications. There is also an unjustified substitution of sociological parameters for what have been so long considered as objective parameters, e g transfer pricing in the article on organisational goal by A. Charness as well as in the article on organisational decision-making by A. Whinstone.

Perhaps the most misfit article is by S. Goldberg on the transport plans for a linear city under the broad section 'Social Effects of Policies and their Measurement'. In this article there are no social effects let alone their measurement. As many as ten out of a total of forty three articles do not relate to Sociology directly or indirectly (unless one stretches one's imagination so far that he will be in a position to contribute another paper). Further editors of symposia or compilation volumes on sociometrics should follow at least a basic set of norms, viz, assure that the articles treat (a) measurability of social parameters, (b) social factors affecting the situation under analysis, (c) social factors affected by the situation under analysis, (d) interaction of individuals in a social environment rather than bringing in human factors at the level of an individual.

The articles which do conform to the above norms are of high merit and discuss valuable methodological frameworks which constitute original contributions to the application of OR to sociology. The importance of the OR approach to sociology has been adequately emphasised. It is comforting to note that this awareness has penetrated the minds of decision-makers of consequence in India too. The planning commission has as one of its members a specialist in applying OR methods to socio-economic problems. And, the Jawaharlal Nehru University used OR for planning its computer-based inter-disciplinary activities of the Schools of Social Sciences and Computer and System Sciences.

Usha S. Herle

... briefly

A Source Book in Biology. Ed. Thomas S. Hall (Harvard University Press, 1970; $ 12·50).

For the student of biology who does not have the time to wade through the great classics of biology, this is a handy " quickie ". There is da Vinci, there is Cuvier, there is Linnaeus. Most of the scientists contributed in their own way to the house of science, though their ideas are no longer valid. Useful reading for those interested in the evolution of scientific thought.

Harvest of Death (Chemical Warfare in Viet Nam and Cambodia). J. B. Neilands, Gordon H. Orians, E. W. Pfeiffer, Alje Vennema and Arthur H. Westing (Free Press, New York, 1972; $ 10).

This volume should be of enduring interest to researchers on warfare. The USA has the distinction of having waged a full-scale war without damage to its own territory and

minimal loss to its own population. The Viet Nam war is unique, too, for the bizarre variety of weapons employed, particularly chemical ones, and this book is bound to become a source book on chemical warfare.

Survey of the Universe. D. H. Menzel, F. L. Whipple, G. de Vaucouleurs (Prentice Hall, Englewood Cliffs, N. J., 1971; $ 16·50).

A number of popular expositions of astronomy are available, but for serious readers, particularly science students, this is an excellent survey. Considering the current interest in space exploration, the chapter on this subject, as well as that on exobiology, should be particularly welcome.

Since Silent Spring. Frank Graham, Jr (Pan Books Ltd., 40 p.).

A rash of books on ecology has appeared in recent times, and is symptomatic of man's guilty feelings about the planet he has despoiled. We may not be able to stop growth — at present — but we can do something about more sensible methods of insect control than the use of insecticides. Rachel Carson's book did much to induce rethinking about insecticides, and the present book is a follow-up and a substantiation of her warning. ■ ■

brain teasers

The bus trip

The local transport company introduced a new route on its town bus service network. They wished to see if it was a worthwhile route. At the end of the day they began their analysis to find out the passenger response. This is what they found. When the bus left from its starting point it had passengers to half its capacity. At the first stop half these passengers got off, and the bus proceeded with 2/3 of its capacity after taking in more passengers. At the second stop, half the passengers again got off. More got on and the bus left with 3/4 of its capacity. Again, at the third stop, half the passengers got off. The bus then went to its destination after taking on more passengers with just one passenger less than its maximum capacity. How many passengers travelled by the bus on that experimental trip ?

A clockwork problem

It happened on Sunday. Ram dropped in to Raju's house to invite him to a film that day. There was Raju, on the floor, screwdriver in hand, busy with two opened-up clocks in front of him.

" What's up, " said Ramu curiously.

" It's these clocks, " Raju said despairingly. " This alarm clock goes two minutes slow each hour while this wall clock picks up five minutes every hour. "

" Forget the clocks, " said Ramu. " Let's got for a movie. "

So forget the clocks they did. Raju just set both at 12·00 o'clock and off they went for a movie.

Several days later Ramu again dropped in to Raju's house. And the clocks struck his eye right away. For they were both showing the same time to the second (not fraction of a second) though not the correct time.

" Did you repair them, " Ramu asked Raju.

" No. Didn't have the time. Just wound them daily and let them run, " said Raju.

So could you figure out the day and time of Ramu's second visit ?

The multiplying flowers

A sadhu, on a pilgrimage, came to a dark forest. He wandered deep into it when suddenly he came upon a clearing. There stood four temples with a large tank in front of each. And in a garden grew the most beautiful flowers he'd seen. He went to each temple and found the first three dedicated to different gods. But in the fourth he found five different deities. That made a total of eight gods in four temples. Being a holy man, the sadhu went to the garden and picked a few flowers. He dipped them into the tank in front of the first temple. Behold the flowers were doubled. He offered some to the deity. Going to the second tank he dipped the remaining flowers into it. He got out thrice the number of flowers. After offering some to the second deity he dipped the rest into the third tank. They were quadrupled. Again he offered some to the third deity and dipped the rest into the fourth tank. He divided the bunch which had multiplied five times between the five deities in the fourth temple. Then suddenly it struck him. He had offered the same number of flowers to each of the eight deities. How many did each deity get and how many flowers had the sadhu picked from the garden ?

Shaik Mahmood

(*Solutions next month*)

you too can do it

Treble Boost Pre-amplifier

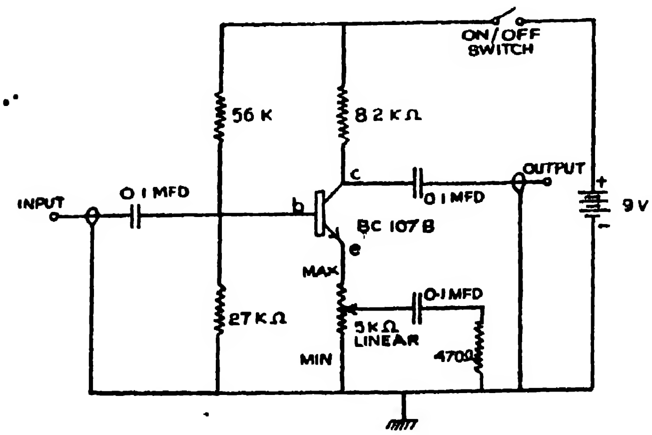
THIS is the age of the electronic sound culture. Especially in music. Beat groups throw out wild, pulsating, arhythmic, syncopated electronic music from their guitars, drums and throats. And the volume is hiked up several decibels for added sensual pleasure. If you belong to this aural generation or even if you are just part of the audient culture this device might prove attractive. It is a device that increases the volume of the treble frequencies of any electronic stringed instrument. It is a transistorised treble boost pre-amplifier.

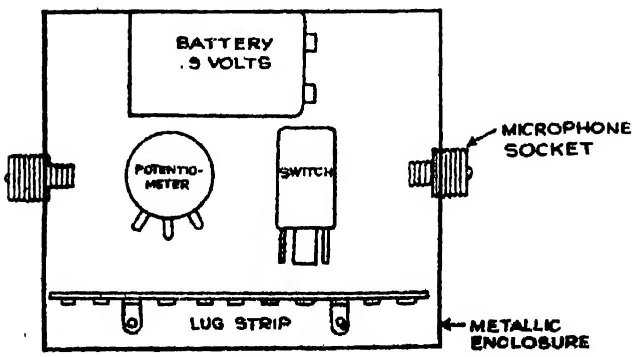
Amplifier circuit stages with transistors fall into one of the three types known as the common base, common emitter and common collector circuits. The majority of amplifiers fall into the common emitter type. In these common emitter amplifiers, the base current requirement is small. Hence the input impedance is fairly high. The collector resistance is a few thousand ohms and the amplification available is the highest as compared with the other two circuit configurations.

Among transistors too there are types — two to be exact, the NPN and the PNP. The middle letter of each type, i e P in the first and N in the second, indicates the polarity of the collector and base voltages with respect to the emitter and vice versa.

The simple circuit shown here is basically a single stage common emitter amplifier. A capacitor in the emitter circuit reduces the amount of negative feedback and thus increases the amplifier gain. The capacitor in such applications is called a bypassing capacitor.

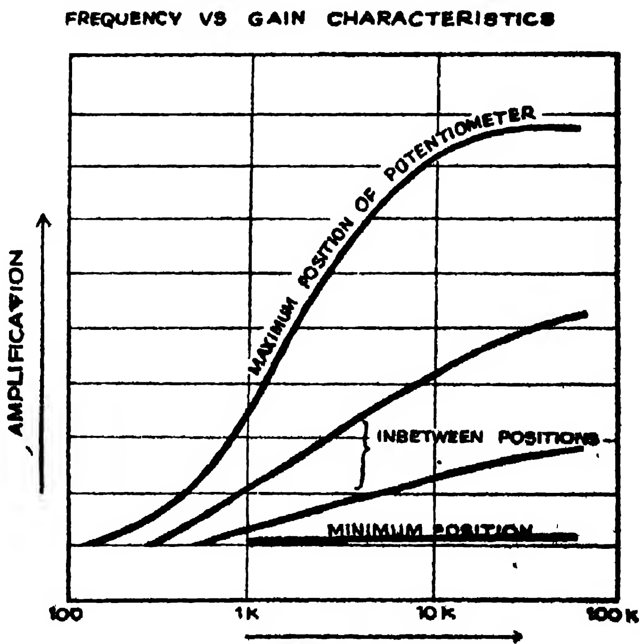
Instead of the fixed resistor in the emitter path, the transistor has a potentiometer. The variable point of the potentiometer is connected to the series combination of a resistor





Left top : The circuit diagram of the treble boost pre-amplifier

Left bottom : The position of the components



and a capacitor. The capacitor is so selected that the reactance offered by it varies considerably, as compared with an emitter resistor, over the audio frequency spectrum. That is, the reactance at 100 Hz is 15K ohms and at 10K Hz is 150 ohms. When the variable point of the potentiometer is at the maximum position, the capacitor will have the maximum influence on the gain of the amplifier as the frequency is increased. This influence will go on reducing as the variable point is shifted towards the other end.

You will need:

Transistor: BC 107B, 1 piece. *Capacitors:* 0·1 mfd, 3 pieces. *Resistors:* All $\frac{1}{8}$ watt, 56K ohms, 1 piece; 27K ohms, 1 piece; 8·2K ohms, 1 piece; 470 ohms, 1 piece. *Potentiometer:* 5K ohms, 1 piece. *Miscellaneous:* Lug strips or group board, flexible wires and solder, microphone plug sockets — 2 pieces, shielded wire for input and output connections, knob, on/off switch, 9V battery.

Anil V. Borkar

ROUND-UP OF RESEARCH

(Continued from page 31)

the sample quenched in oil did not crack. Second, they quenched the steel directly from 1,200°C again to find that only the sample quenched in oil did not crack. However, this sample had a fracture toughness 70 per cent greater than that which survived the first test. Third, steels austenised at 1,200°C were cooled to 870°C before quenching. In this case, all the samples quenched in the three different media were uncracked and had fracture toughness almost as high as the surviving sample quenched directly from 1,200°C.

The American scientists hence conclude that to achieve high fracture toughness, there is no need to quench the steel directly from the high austenising temperatures. In fact, such a direct quenching often causes the steel to crack. On the other hand, a two-stage quenching process minimises the danger of quench cracking with no deterioration in the strength of the end product. They do not, however, offer any explanation as to why quenching in oil is less likely to cause cracking of the steel.

K. A. Neelakantan

Solutions to last month's Brain Teasers

POLISHED OFF

An hour and 20 minutes.

If she took 8x minutes for the first, she took 12x minutes for the second and 15x minutes for the third. Altogether she took $(8 + 12 + 15)x = 35x$ minutes. Six hours less ten minutes is 350 minutes so $x = 10$, $8x = 80$ minutes or 1 hour 20 minutes.

HOLIDAY HAUNT

Not much beyond waste.

The bath would take an hour to fill. During each minute, the taps poured in hot 1/30 and cold 1/20 of capacity, the drain lets out 1/15 of capacity. So the filling rate is $1/30 + 1/20 - 1/15 = (2 + 3 - 4)/60 = 1/60$ of capacity. Thus the bath takes 60 minutes to fill.

CHEESE ACT

90 paise.

If the old price was x paise for half a dozen, the new would be $(x + 15)$.

So $6(210/x - 210/(x + 15)) = 2$ or $3\ (210(x + 15) - 210x)/x(x + 15) = 1$

So $630 \times 15 = 90 \times 105 = x(x + 15)$

Hence $x = 90$.

TECHNOLOGY NEWS

(Contd. from page 45)

fuel elements. Besides, these studies will also help scientists to study the mechanics of the fast breeder reactor, which can produce more fuel than it consumes. The 15 MW (e) test fast breeder reactor in India is being built at Kalpakkam near Madras. Based on French design, the plant will be fabricated by Indian scientists.

The zero-energy core at Trombay has plutonium oxide fuel elements fabricated at Trombay itself, and molybdenum, copper and steel reflectors. The use of plutonium oxide needs special care as plutonium has a shorter half-life and therefore there is a more rapid rise of power than in the uranium systems. For this, the Trombay reactor has three control rods which are set off independently at a signal, and the core drops. ■ ■

looking back

Did the Stars Foretell?

CLAUDE BERNARD (12 July 1813) : On a warm day the blood vessels of your skin dilate to carry more blood and keep you cool by losing heat; conversely, on cold days they contract. The temperature of the body is thus kept constant.

The constancy of the living organism's "internal environment" — what is known today as "homeostasis" — was first appreciated by Bernard, a French playwright who in his twenties became a student of the pathologist Magendie. In a way, his work prepared the ground for the study of endocrinology in medical science.

He arrived at this basic concept of biology after a great deal of experimental research and analysis. Cutting one of the nerves of the neck, he observed that in certain parts of the head the temperature went up and more blood flowed. Evidently the nerves controlled the dilatation and contraction of the blood vessels and thus regulated the supply of blood There is complete integration between all functioning parts of a normal body, and this integration depends as much upon the nervous system as upon "the blood and lymph which bathe all the cells".

There is also a chemical balance in the body. Bernard found that the animal liver builds up glycogen from blood sugar and uses it as a reserve carbohydrate, breaking it down into sugar when necessary. The amount of glycogen is manipulated in such a way that the sugar content of the blood remains steady.

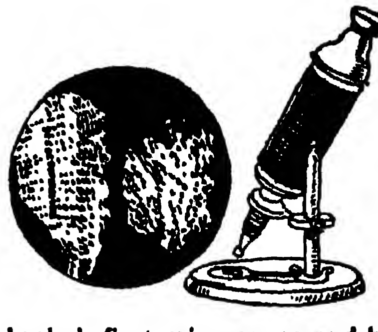
Bernard's first study of importance was the working of the pancreatic gland. He showed that if the flow of the pancreatic juice into the intestine is stopped, fats remain undigested. He went on to show that the main part of the digestion of food, particularly fats, took place in the small intestine, though some of it took place in the stomach.

Bernard also studied the physiological action of poisons on muscles and by observing their behaviour when injected, showed that muscles can contract independently. His *Introduction to the Study of Experimental Medieine* (1805) is still considered a classic.

He died on 10 February 1878.

ROBERT HOOKE (18 July 1635) : You must at some time or other have seen a spring balance. Notice that the stretching of its spring is proportional to the weight used. It was Hooke who discovered this incredibly simple principle—now known to every student of physics and engineering — on which the spring balance is based. He put it into the words: "the stretch is proportional to the force."

Though Hooke is best known for this law, in point of fact he made discoveries as significant as those of Newton, Huygens and Leewenhock, though he is not always given credit for them. It is clear that he anticipated Newton's theory of gravitational attraction by at least five years. He was aware that "this attraction would vary inversely as the square of the distance from the Sun". In fact, when Newton published his *Principia*, Hooke thought that he had made use of some of his own work and for some years the relations between the two scientists were strained.



Hooke's first microscope and his drawing of cork cells

Hooke's most significant contribution was to initiate the microscopic study of living organisms. Besides designing and constructing a practical compound microscope, he also made observations and interpretations. It was he who introduced the idea of the "cell" as the basic unit of structures making up the tissues of organisms—a concept as important as that of the atom in chemistry.

Hooke studied the nature of combustion. Burning, he thought, was caused by a "dissolving" substance in the air, in whose absence there would be no burning—thus foreshadowing Priestley's work on oxygen. He extended this view to living organisms, and considered respiration to be a kind of combustion.

His study of springs led him to use a spring to control the oscillations of a balance wheel in watches, for pendulum clocks were found to be very inconvenient for use on board ships.

Hooke died on 3 May 1703 — and today there is not even a gravestone to mark the spot where he lies.

JOHANNES PETER MULLER (14 July 1801 — 28 April 1858) : Like many scientists, Muller narrowly escaped entering the church. This German physiologist and comparative anatomist was the first to integrate the entire knowledge gained by scientific methods in the first half of the 19th century in the pursuit of biological studies. One of the first to use the

microscope in pathology, he made significant contribution to the minute anatomy of malignant growth.

His most important discovery was that the basic nature of impulse in all nerves is identical — whether the stimulus is light in the case of the optic nerve or sound in the case of the auditory nerve. The difference in sensation is caused by the analysers in the central nervous system.

Muller contributed to our knowledge of reflex action and showed that in frogs, cutting the ventral roots of the spinal nerves gives rise to paralysis of muscles, and stimulation of the peripheral ends causes contraction of muscles; cutting of the dorsal roots results in a loss of sensation of the parts concerned. He demonstrated that when the central end is stimulated there is pain and reflex motion.

Of special importance are his discoveries of the ducts in the embryo from which the adult kidneys are formed, (now known as Mullerian ducts), and lymph-hearts in the frogs.

FRIEDRICH WOHLER (31 July 1800): Nowadays scientists are realising that knowledge is one, and that scientists cannot function in water-tight compartments. Thus, an astronomer often requires a knowledge of physics and biologists have to be chemists too and the number of inter-disciplines is growing.

In Wohler's time the general opinion was that the formation of

organic substances depended upon some special "vital force" and was therefore quite beyond the scope of chemical analysis. By producing urea in his laboratory (an organic compound occurring in urine as a result of protein breakdown in the liver), Wohler broke down the distinction between inorganic and organic chemistry.

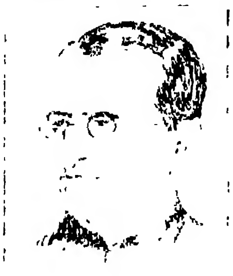
While studying in Sweden he prepared a compound of nitrogen, carbon, oxygen and silver, called silver cyanate. It so happened that another German chemist Liebig had prepared a compound with the same chemical make-up, but with different properties. It was then realised by chemists that two chemicals could have the same ratios of the same elements but with a different arrangement — a phenomenon which they called "isomerism."

Wohler continued his work on cyanates. Treating potassium cyanate with ammonium sulphate he made his great discovery. White needle-like crystals of ammonium cyanate or urea, came out of the solution. He had created a substance hitherto thought to be formed only in living cells.

Urea is today used in agriculture, in cosmetics, in medicine and in plastics. But it is only one in a whole range of artificially created organic compounds — the first of which was synthesised by Wohler.

Wohler died on 23 September 1882.

GREGOR JOHANN MENDEL (22 July 1822): In 1900, the

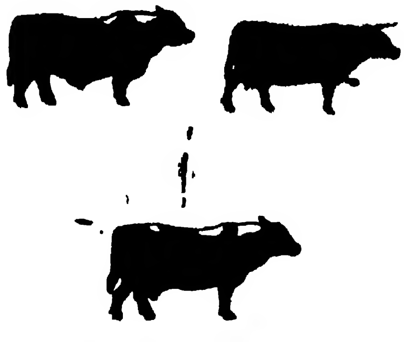


Dutch botanists de Vries and Correns, and the German Von Tschermak, studying the mechanism of evolution, discovered some things about heredity that an Austrian monk, Mendel, had discovered nearly forty years earlier. Mendel's findings are central to the understanding of heredity in living beings.

Up to Mendel's time people knew in a vague way that some characters are passed from parent to offspring, while others may skip one generation and appear in the next. Mendel's success in studying heredity came from his realisation that the clue was the study of a single character at a time.

To be free of the anxiety of earning a livelihood, he entered a monastery at the age of 21 and spent his leisure hours in the monastery's garden. He noticed that when tall garden pea plants were cross-pollinated with dwarf ones, the offspring were all tall — not a mixture of tall and dwarf plants as one would expect. He crossed the (tall) offspring with one another, and this time he got tall and dwarf plants, in an interesting ratio: of every four plants, three were tall and one dwarf. Mendel surmised that the "dwarf" trait was not lost during the first mating: it was merely masked or dominated by the "tall" trait. He called this phenomenon "dominance".

By further crossing, he found that of the tall hybrid plants of the second generation, about two-thirds would continue to give



Dominance. Black coat and hornlessness are dominant to red coat and horns, hence offspring are black and hornless

offspring in the 3 : 1 ratio, while the other one-third were "pure" talls. The dwarfs, on the other hand, always bred true. From such experiments, Mendel drew up his "Law of Segregation" and "Law of Independent Assortment" — the first attempts to systematically study heredity.

Why did his findings remain in obscurity for so long? For one thing he sent them to a botanist, Nageli, who believed that any scientific work should involve some theorising, and all that Mendel had done was to do some counting and establish some meaningless ratios. For another, Mendel later got his work published in an obscure Austrian journal where it collected dust until its rediscovery in 1900. Mendel died on 6 January 1884.

S. N. Munshi

things we use

CONTACT LENSES

ABOUT 85 per cent of contact lens-wearers are girls between the ages 15 and 25 years, claims an optometrist, but boys will not lag behind for long, adds another. Cosmetic enhancement and (wo)man's vanity are the factors that have popularised them. But that is not all. Contact lenses have been proved to be as good, or even better than the conventional spectacles in many instances.

The lens is a tiny concave disc. It rests on the cornea, and is held in place by surface tension and the capillary action of the tears (fig. 2). The inner surface of the lens is made to match the curvature of the eye. Consequently the powers have to be ground on the convex side (outer surface) of the lens. Originally glass was used for the manufacture of contact lenses. Now plastics (methyl methacrylate) have replaced glass. Rods of plastic are cut into buttons of six to seven mm. thickness and shaped by a curvature cutting machine to the required dimensions. There was a time when the lenses were blown. But the accuracy could not always be ascertained. Obrig and Muller made contact lenses by making casts of eyes and moulding lens on them. Lathes were also used to grind contact lenses.

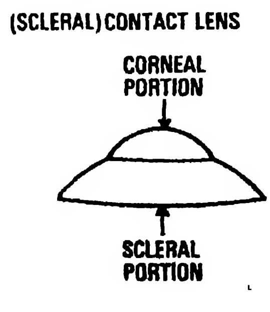
An opthalmometer or a keratometer is used to measure the curvature of the patient's eye. Besides this, the thickness of the liquid layer between the lens and the eye is also taken into account. This liquid layer also acts as a lens. Thus afocal lenses — lenses without power — were used in the past to correct eye defects, where the necessary power was adjusted by the intermediate liquid lens.

On fitting, the lens is checked for its smoothness and accuracy by introducing a fluorescent dye into the eye. The thickness of the liquid is measured, using a strong cobalt blue light. Unevenness is seen in the difference in the intensities of fluorescence. If the fitting is poor, it causes irritation and swelling. In spite of a proper fit, some eyes react violently to the foreign body placed on them. Prior medication is necessary in these cases. The ideal thickness of the liquid lens should lie between 0·05 and 0·1 mm in the central area for about 1·0 mm around the limbus. The tears should circulate freely and facilitate the exchange of gases.

BASICALLY there are two types of contact lenses. The scleral or haptic lens (fig. 1) covers the entire visible portion of the eye and measures about 23 mm in diameter. This lens is distinguished into two parts. The central corneal part which is powered, is separated from the eye by a film of tears. The rim rests on the white of the eye — the sclera. Such lenses are prescribed now only where the smaller ones cannot be used. In people suffering from keratoconus — a condition where the cornea keeps protruding outwards — the scleral lens acts as a support from outside. Swimmers who must have visual aid use scleral contact lenses. In all other cases the smaller corneal lenses are preferred for the scleral lenses are cumbersome, difficult to insert into the eye and cannot be worn continuously for a long time. After every three to four hours they must be removed to refresh the oxygen-starved eye.

Corneal contact lenses are small and rest on the dark portion of eye. At first they were available in sizes between 10 and 14 mm diameter. The present day microlenses are about eight mm and cover only a part of the cornea. The corneal lenses are smaller, easier to wear and can be kept on all day long. The cosmetic contact lenses are coloured (and cover the whole cornea) to change the colour of the

Fig. 1 The first contact lenses were all of the scleral type. Only the central portion which lies in line with the dark portion of the eye is powered. The non-powered broad rim rests on the white of the eye. These lenses are prescribed only where the small corneal lenses cannot be used, for they are cumbersome and tire the eye



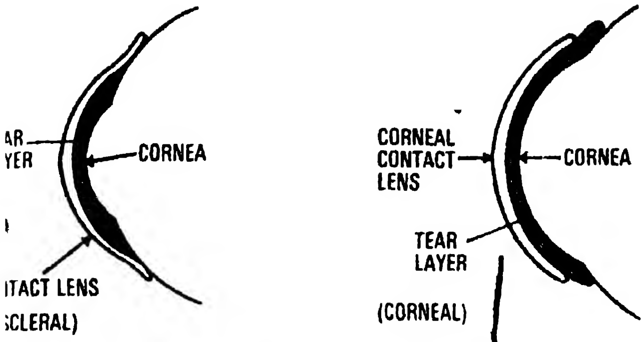


Fig. 2 Between the contact lens and the eyeball there is a thin film of tears which too behaves like a lens. The renewal of the tears ensures sufficient oxygen supply. Scleral lenses have to be removed periodically to refresh the eye

wearer's eye. Excess of tears tend to wash out the microlens. The eye should therefore be protected from irritants.

When one eye is disfigured a corneal prosthesis, a thin shell which fits the eyeball like a scleral lens — and matches the healthy eye — can be used. It is better than an artificial eye in that it moves and cannot be easily detected.

Bifocal contact lenses are costlier and not yet common in India. There are two types of bifocal contact lenses. One has the reading segment at the base of the lens. This lens is held in position by providing it with a prism below as ballast. The second variety consists of a reading segment all around the periphery and the distant vision at the centre. However, the reading section is small and many doctors feel it is not practical to use. They recommend wearing reading spectacles over the contact lenses instead. The lens moves slightly upwards when the eye is lowered and lifts the reading segment over a part of the pupillary area (fig. 3).

When the lids press the lens during blinking it is flattened and the power is changed. Heat and wind dry the lens and thus affect the power. Since the lens clings to the eye surface any irregularity on the cornea is reproduced on it; hence it cannot be used for astigmatic eyes. It is found useful for shortsight but does not help a long-sighted person much. There is a limitation to the powers that can be ground on it. Then again maintaining it is a problem. It has to be sterilised every night to prevent microbial infection. India being a tropical country chances of fungal infections are greater. Its cosmetic value is higher yet it may not successfully compete with the hard contact lens as a visual aid. However, it has found therapeutic uses. Being absorbent, it retains chemicals and is therefore used as eye bandage and for sustained drug medication. But it is this very property that makes it dangerous to a normal wearer, for toxic chemicals and gases absorbed are kept in contact with the eye for prolonged periods. So if you are wearing a pair of soft contact lenses and you are unfortunately tear gassed — SCRAM! An American firm has now developed an oxygen-permeable plastic for contact lenses which makes the hard lens as comfortable as the soft ones.

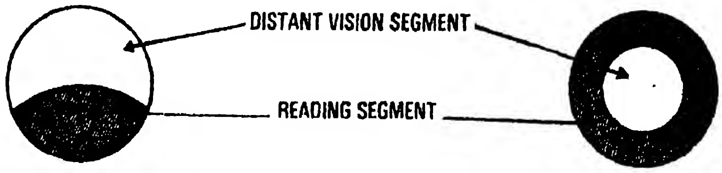


Fig. 3 Bifocal contact lenses are of two types. One has the reading segment at the base like in spectacles. It is weighed down with a prism to prevent this part from going up. To overcome this difficulty the second type has the reading segment all along the periphery

SOFT LENSES. In Europe and America soft contact lenses are now available. When dry this lens is brittle, but when inserted in the eye it absorbs tears and becomes soft and gelatinous. It is more comfortable than the hard contact lens especially in the early stages for the eye adapts to it faster. This is because the lens partly anesthetises the cornea and does not feel like a hard obstruction. Also it is porous and allows free respiration. It clings more firmly than the hard contact lens, and so chances of its falling out are rare. But it is very expensive, and tears and splits easily in spite of gentle handling. This makes replacement costly. Again the wearers often experience blurring of vision.

CONTACT lenses are superior to spectacles in many ways. There are many cases where spectacles are of no use at all — like in the keratoconus patients. Again if the disparity of the powers between the two eyes is great, spectacles cannot prevent the formation of double images. Contact lenses are used for such patients. Cataract-operated patients also find contact lenses and a pair of spectacles over it more comfortable than the cumbersome telescopic spectacles. When a person is operated for cataract in one eye only — as in traumatic cataract where the lens in one eye of a child loses its transparency due to physical injury — contact lenses are the best of visual aids

available. A contact lens power has to be changed less often than normal spectacles, and even then the change number is small since the lens adheres to the eyeball. Again since the lens is close to the eye, a myopic person does not see smaller images with the negative powered contact lenses as with spectacles. Constant wearing of contact lenses presses the cornea and so reduces the negative power of the eye, but when given up, the eye regains its natural curvature soon.

There are certain diseases where contact lenses cannot be used, like glaucoma or any disease which causes a person's hands to shake or the eyes to water.

The world's first contact lens was made by a West German glass blower in 1887 for a person with diseased eyelids. The purpose of the lens was to prevent the lid from touching the eye. A year later the powered contact lens came into being. As early as 1508 da Vinci had conceived the idea of using a lens touching the eyeball. The twentieth century saw the contact lens progressing in leaps and bounds — huge haptic lenses gave way to corneal lenses and now microlenses rule supreme.

Sumati K. Samnemane

Letters

Contd. from page 7)

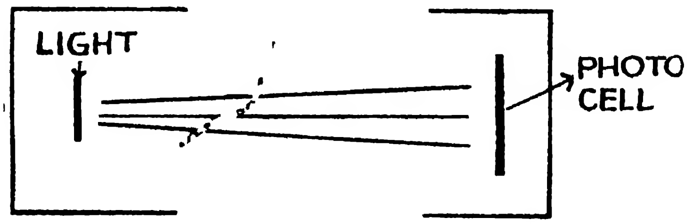


Fig. 5 (a)

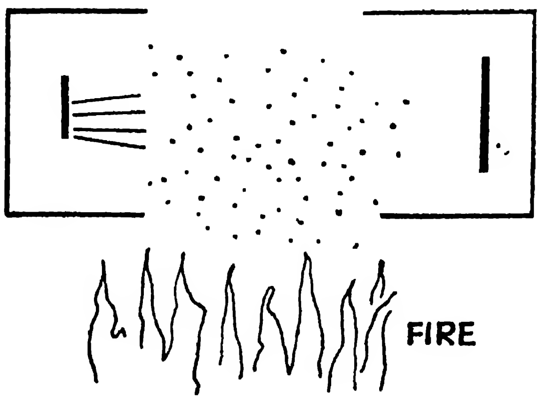


Fig. 5 (b)

and reduces the current. This reduction in current is made to actuate the fire alarm. Fig. 5 (a) & 5 (b).

4. Ultraviolet detection: As most of the ultraviolet light is absorbed by the ozone in the upper atmosphere, that produced by the flame could be detected by a photocell sensitive to ultraviolet rays. A false alarm may be caused by welding and some electrical apparatus.

S. M. Desai

Editor, Fire and Fireman, *Bombay*

Moulders of men:

the men behind the machines, at the desks and drawing boards. The men who lead and manage at Indian Oxygen.

Even in the age of machines, in the final analysis it is man who moves and decides. IOL is aware of this. That is why IOL takes pains to select the right man. That is why in IOL the accent is on training, on moulding, on developing men at all levels from the workman to the top management. Deeply committed to professionalism in all fields, IOL is training and developing a new breed of managers and technologists to cope with the current and future needs of Indian industry.

Indian industry needs INDIAN OXYGEN

IOL

IOC-199

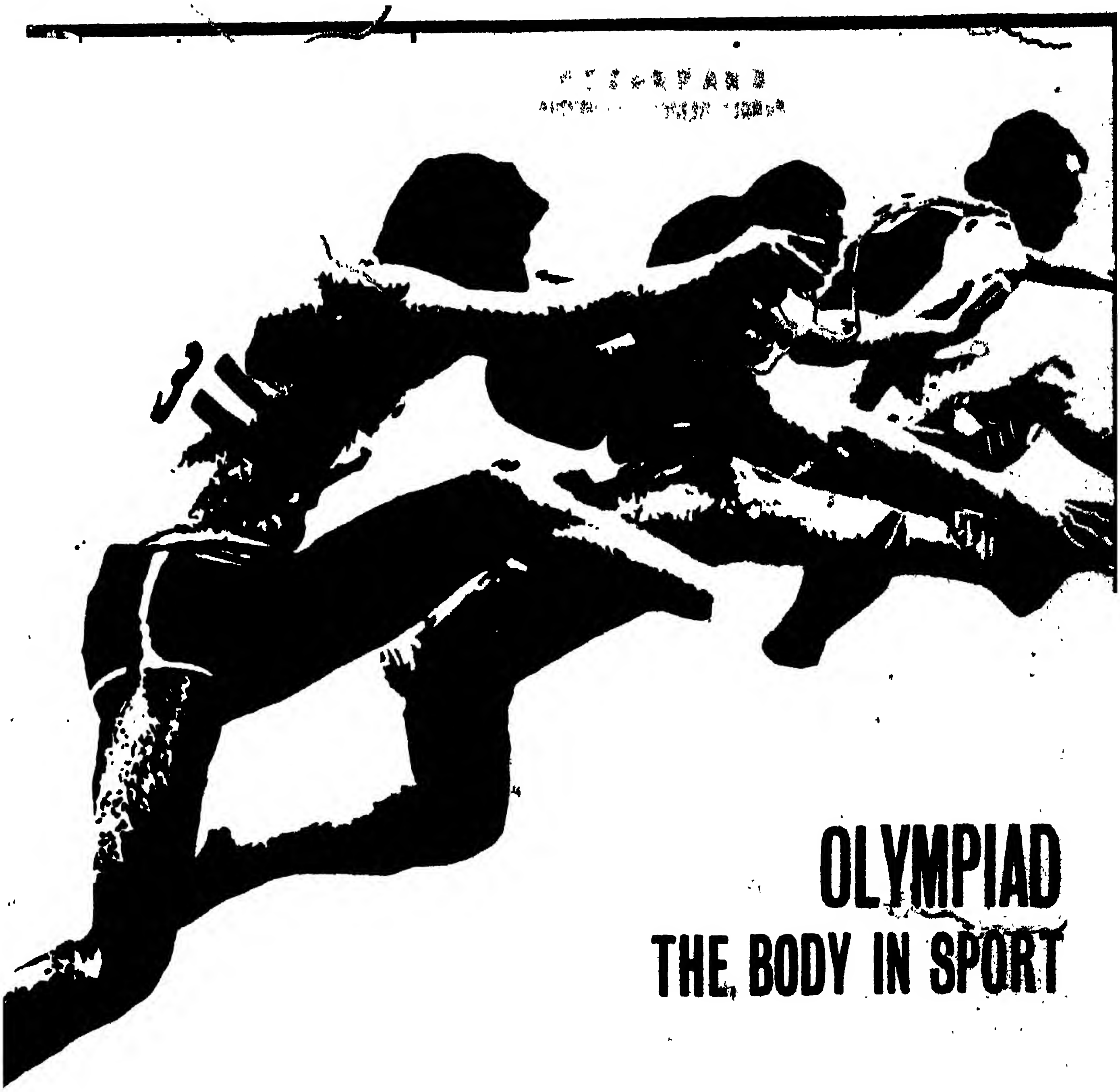
Regd. No. MH 1368

A TIMES OF INDIA PUBLICATION

AUGUST 1972

SCIENCE TODAY

FOR EVERYMAN

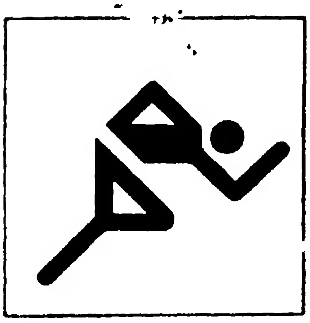


OLYMPIAD
THE BODY IN SPORT

Rs. 1.25

SCIENCE TODAY

VOL. 7 NO. 2
AUGUST 1972



p 42

COVER
Man was not made to be a runner, but . . .
(Designed from a Munich Olympic poster by Shabbir Diwan)

Rs. 1·25; 10p
Annual Subscription
Rs. 12·50

EDITOR
SURENDR JHA

ARTICLES

FEATURES

Printed and published for the proprietors Bennett, Coleman & Co., Ltd., by Uma Shankar at the Times of India Press, Bombay, India. Delhi Office: 7, Bahadur Shah Zaffar Marg, New Delhi 1; Calcutta Office: 13-1 and 13-2, Government Place East; London Office: 3, Albemarle Street, W.1.

Deadly lead prevents birth

Lead in high doses is fatal. In smaller amounts it prevents birth. A high lead content in the bloodstream reduces fertility and consequently, the birth rate. Automobile exhausts foul the city air with lead compounds. On an average a city dweller absorbs 16 micrograms of lead each day. An American has 0·2 ppm of lead in his blood.

Researchers at the University of Missourie Medical Center, USA, fed lead acetate to two sets of male rats (0·05 and 0·16 micrograms). A month later, the lead in their bloodstream was found to be 0·192 and 0·286 ppm respectively. The prostate cells had multiplied abnormally and this led to a decline in prostatic secretions.

Say when

Do you know when you've had enough of water ? At least your tongue does. The cooling it undergoes signals satiation. Hence cold water quenches thirst quicker than warm water. Indiscriminate consumption of water too has its side-effects. Too much of cold water in a cold climate could result in a serious drop of body temperature, too little of water in a hot climate could lead to dehydration. Gregory Kapatos and Richard M. Gold, researchers at the State University of New York, USA, claim the temperature of water and the intake are correlated. They deprived rats of water for 23½ hours and allowed them a drink for half an hour. They found that when supplied with cold water the rats drank very little. The amount consumed went up till 36°C. At higher temperatures approaching the pain threshold, the water intake again dropped. It goes to show that the water-intake system favoured by evolution relates the body's needs to the temperature of the surroundings.

Immunological soothsaying

In the near future the immunologist may become a soothsayer too. It may soon be possible to predict with a tiny drop of a newborn baby's blood, the diseases he is likely to suffer from in later life.

Invasion by a foreign body triggers the production of sensitised lymphocytes (a type of white blood cells) and specific antibodies to ward off the enemy. Years ago, it was found that in guinea pigs and mice the immune response (Ir) was controlled by single genes in a drastic manner. The animals succeeded in entirely subduing the invader or succumbed without a fight at all. These genes are located near the histocompatibility genes — that determine the acceptability of transplanted organs — and not near the genes controlling antibody structure. They can be either dominant or recessive.

The position of the Ir genes goes to show that they are a complex version of the ancient cell recognition system of primitive organisms. A proper understanding of these genes will explain why some people are immune to certain diseases whereas others are not.

However, the ability to foretell an individual's proneness to certain diseases also brings in ethical problems. What is to be done if the new born is surely heading for disaster ?

Four-week old fresh eggs

It is possible now even at room temperature, claims the Central Food Technological Research Institute at Mysore. It has developed a new formula of preservatives and petroleum products for treating the eggs. About one litre is sufficient to treat 3,000 eggs, and the cost works out to 20 paise for 1,400 eggs. After filteration and sterilisation the chemical can be re-used.

Protective herbicide

Rolling back the forest has a major set-back — weeds. Start cultivating a forest land and weeds intrude, taking up much of the nutrition and water the seedlings need. Scientists have developed a new herbicide which can be linked into the bark of trees. It spreads slowly into the ground and chokes weeds. When tested it reduced weeds three-fold and nearly doubled the growth of seedlings.

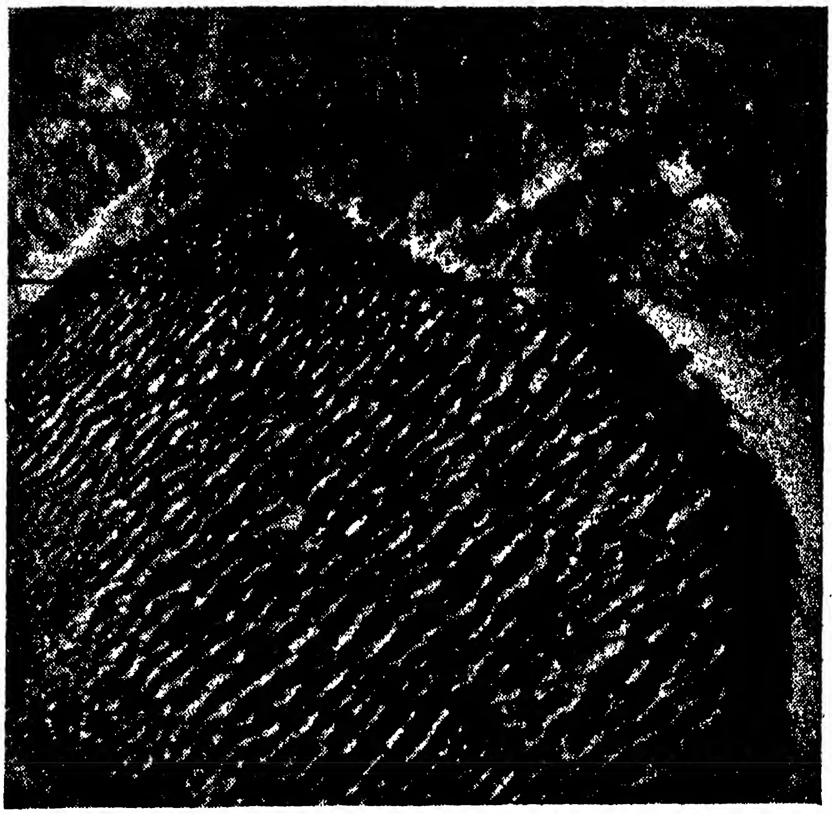
Take heart—you may keep it

A borrowed organ need not mean borrowed time much longer. Immunosuppressive drugs retard the rejection mechanism, but they also lower the body's resistance to disease. A group of researchers at the Medical University of South Carolina, USA, seem to have a solution for this problem — selective immono-suppression.

The presence of a foreign material within the body excites the production of specific lymphocytes and antibodies to overcome it. Each invader has to be dealt with by a special type of lymphocyte.

In a series of experiments, the scientists immunised cows against TB. The lymph of the animal was drawn out and passed through a filter containing glass beads coated with TB antigen. The antibodies against TB were trapped and the cow was de-immunised. With the animal immunised against two diseases, TB and histoplasmosis (a fungus disease), they were successful in suppressing antibodies against any one disease. This method could be applied to man so that he can keep transplanted organs without having to cope with low resistance to disease.

Wind tracks on Mars?



Sand dunes are a result of winds. Mariner 9's narrow angle camera has shot a dune-covered Martian crater floor — evidence of strong southwest winds blowing across the surface of the red planet. The crater is in the Hellespontus region and is about 128 km long and 64 km wide. The largest dunes lie about 1·6 km apart. Like the earthly dune fields, the peripheral dunes are smaller than the central ones. It is possible that the winds have deposited dunes on other crater floors as well.

Blueprint for mental development

It is a common belief that genetic factors govern the mental development of a child. If this be true, then the growth and drift periods of twins should harmonise to a certain extent. In the case of identical twins, they should coincide to a greater extent because of their identical genetic make-up. Ronald S. Wilson of the University of Louisville tried to verify this hypothesis by studying 261 pairs of twins between the ages of 3 and 24 months. His conclusion: genetic coding has much to do with mental development; maternal care and socio-economic level are just minor factors.

Radiation-resistant bacteria

The food industry may soon have to look out for a more foolproof method to sterilise its products. Some bacteria have learnt to remain unaffected by the ionising radiation technique used for food preservation. At the Massachusetts Institute of Technology, USA, mutant strains of the salmonella group (typhoid group) were developed by exposing them to radiation. At first the bacteria were exposed to a small dose of radiation, and the dosage was increased subsequently. The mutant strains were 20 times more resistant to radiation than the normal ones. This acquired resistance is a genetic trait and can also be passed on to normal bacteria.

One more in the string of pollutants

One would never guess ozone was an air pollutant like sulphur dioxide, carbon monoxide and the hydrocarbons. It was generally believed that it is a beneficial component of fresh air. The same ozone that prevents the fatal short-wavelength radiation from reaching the earth is harmful in itself if its concentration goes beyond one ppm. The ultraviolet rays of the Sun react with oxygen and convert it into ozone. Ozone is also a product of electrical discharges. Hence in some cities its concentration builds up to 5 ppm by mid-day — especially on smoggy days.

Dr. D. V. Bates and his fellow scientists of McGill University, Montreal, Canada, studied the effects of excess of ozone on the human lung. Volunteers were asked to stay for a two-hour period in a chamber where the ozone concentration was regulated to 75 ppm. At the end of this period it was found that all of them developed some respiratory troubles. Some complained of sore throat and chest, some coughed and some even experienced difficulty in breathing. There was an increased resistance to the air flow, the elasticity of the lungs was reduced, when the subjects exerted themselves their breathing rate was doubled and the resistance in all air tubes was increased. Another adverse effect may be on the air-sacs where exchange of gases takes place.

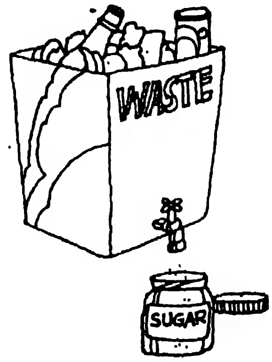
When will it blow its top?

We may soon be able to tell when a volcano will blow its top. Geophysicists carrying out routine surveys of electromagnetic waves near Kilauea volcano in Hawaii found that their equipment did not behave normally. The experiments consisted of generating electromagnetic waves by passing electric current intermittently through a long wire, and measuring these waves at a distance of several kilometres away. While doing this near the volcano their instruments responded even when no current was passed. No plausible explanation was found. But the picture became clearer when the volcano erupted twenty-three days later.

Two theories were put forward to explain this phenomenon — both concerning the movements of molten rock underground. One theory says when molten rock moves through a fissure underground it behaves like a magnet, and thus affects the measuring equipment by generating electromagnetic waves. The other says that the layer of underground molten rock acts like a metallic sheet and magnifies the continuous minute changes in the earth's magnetic field.

Sweet paper basket

Will there be enough of cane and beet to meet the world's sugar requirement ? The US Army's Natick Laboratory has an answer. They have found a way of converting cellulosic waste into glucose enzymatically.



Waste paper — be it bags, cardboard boxes, writing paper or even newsprint — is milled to a particle size of 50 microns and mixed with the enzymes in a reactor. The temperature is maintained at 50°C, and the cellulose concentration between 10 and 20 per cent. When the glucose concentration reaches about 5 to 15 per cent it is withdrawn, and more paper is added to the reactor. The glucose is then purified. It can be used for human consumption, production of chemicals or to grow microbes which are used for production of antibiotics, vitamins, amino acids etc.

The amount of glucose obtained thus is very near to the yield from commercial methods using corn starch.

Viruses to cure viral disease

A virus establishes itself within the host cell by incorporating its own genetic code into the genetic material of the host. When two

different types of viruses meet in a common host, they fight. The winner gains control of the host cell and the loser is killed.

Two scientists of Georgetown University School of Medicine, USA, have found that the polio virus dealt a death blow to the mosquito virus 'sindbis' in the human host cell. Substitute a harmless virus for the harmful winner : You have a viral cure for viral diseases ! How soon ? — that is the question.

Moon's other face

The Moon has one face to show us earthlings. And the other side is always invisible. The crust and surface of the other side are different from that of the side we see. The reason, according astronomer John Wood of the Smithsonian Astrophysical Observatory, is the heavier bombardment on the western side than on the visible side. Meteorites hitting the visible side are concentrated to a focus because of the Earth's gravitational pull on them. The other side is hit at random. The western side collects meteorites like the windshield of a speeding car collects insects, because the Moon moves in a counter clockwise direction. The crust at these points is thinner.

Lighter carbon brakes

Shedding weight is the main problem of aircrafts and obese people. An American firm will help the Anglo-French supersonic Concorde to reduce its weighty problem. They are manufacturing carbon brakes to replace the present steel ones. The new brakes will be more efficient in stopping the aircraft and will weigh 60 per cent less. Another firm in Ohio is making similar brakes to be tried on the supersonic B-1 bombers and F-15 aircraft.

Electric guardian angels?

Like birds and insects, ocean fish migrate too. They travel over thousands of miles to return to the stream where they were born. How they manage to find their way has been a ticklish problem for naturalists. It has been often suggested that they make use of electric fields to chart their way.

The movement of the ocean currents across the earth's magnetic field gives rise to weak electric fields perpendicular to the flow of the current. Many fish have been shown to be sensitive to these fields.

S. A. Rommel Jr. and J. D. McCleave of the University of Maine, USA, studied electrosensitivity of the American eel (*Anguilla rostrata*). Electrodes were implanted in them to record a continuous ECG, and to find out if there was a slowing of heart beat rate in response to the current.

Results from eels which had undergone at least 50 tests showed that they responded to weak electric fields perpendicular to their bodies but not to any parallel fields. Though there is no evidence that eels make use of the current for navigation, they probably do. To swim with the current, all the eel would have to do is maintain its position in such a way that it keeps feeling the current all the time. If it can distinguish the polarity, it can also tell upstream from downstream.

Why Jack survived his broken crown

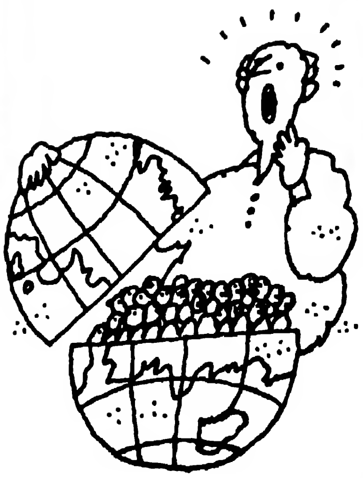
Perhaps little Jill knew that it would not matter much, if she too broke her crown while tumbling after Jack — at least not too much, since she was just a little child.

It is a common belief that children can cope better with brain injuries than adults can.

Professor Hans Teuber of the Psychology Department at MIT is working on animals to verify if the belief is true. There have been some illustrative cases in man. A soldier who suffered a bullet wound in the occipital area of his brain went blind. A man who had suffered a similar injury during his childhood seemed to have no visual defects at all. Prof. Teuber proved with the help of animal experiments that the position of the injury is also of consequence. True, the young monkeys coped better than adults when the frontal lobe of the brain was removed, but both adults and young ones suffered identical behavioural changes when the orbital cortex was damaged. He concludes that if the damage occurs during the developing stage, the cells compensate by rearranging themselves. The disconnected nerve fibres move to the second best place available and help to preserve the function. But sometimes the process goes haywire, and the function may be well preserved but jumbled.

TOO MANY PEOPLE!

" Be fruitful and multiply. " Mankind took the divine dictum literally. Today, next to a nuclear death, mankind's greatest fear is its own reproductivity. The holocaust may begin soon, unless we can arrive at a zero population growth. What are the chances ?



YES, there are too many people. Ask the statistician sitting in your own backyard! The population of India today stands at 548 million. Each year 13 million more are added to the tabulated columns of census reports. Theoretically, they require an additional 125 million tonnes of food, 190 million metres of cloth, 4 million jobs, 1 million admissions to schools. By 1980, two-thirds of all jobs for newcomers must be created. Forty per cent of the population is under 15 years of age — unproductive at the moment and utilising precious resources. When they grow up . . . . Want to open the Pandora's box ? Think of the problems of housing, transport, recreation, community health . . . .

Or, take a look at the world. It took thousands of years for world population to reach one billion in 1850. Within the next 80 years it was two billion. The next 30 years added the third billion (1963). And for the subsequent strand of one billion, the world must age just 16 years. Population doubles quickly.

Resources too multiply. But not with the same astounding speed. You have heard that before? But Malthus hadn't really talked of fear!

The common scapegoat of the prophets of doom is technology. And, they have a point there. For technology has raised certain contradictions. Like medical technology, which has given us effective death control measures and yet has not provided a concomitant and effective means for birth control.

Down with technology ? Is that possible ? When three-fourths of the world is still bogged in poverty ? Grow less food ? Make less medicines ? Let people die now, so that later they don't choke themselves to death ? What decision-maker has that logicians' arrogance ? No, do not do away with technology, say the technologists, the other group. Just perfect technology to suit the world.

ZERO POPULATION GROWTH. But what about man and the social structure ? What supports man's instinctive urge to procreate ? Social institutions, no doubt. And social institutions in themselves have the remarkable plasticity to withstand the test of time. Take the family, for instance. The family has been moulded down the centuries into the basic unit of any society. It was the defence mechanism of societies protecting their living members, breeding newer members for the future. It also bred the feeling that children are the mainspring of the future, that children are the safest investment. The centuries of death, disease and war have set into play the defence mechanisms in the psyche of every individual. One such is the attitude towards offspring. Massive resources and social organisation have gone into the production and rearing of offsprings.

This is where the change has got to start. It will be a stupendous task. You can not tamper with the death rate. If death rate falls, as it must be made to fall, the only way out is to equate deaths and births — a static population or what demographers call the zero population growth (ZPG). This is an ideal, a dream. It requires more than mere statistics of sterilisations, tubectomies, vasectomies, contraceptives, ad infinitum. It involves society and intelligence and the human psyche and other abstracts. The abstractions are important.

THE AMERICAN EXAMPLE. What would it involve to reach such a state of static population? Studies on this aspect of demography are lacking in India, but we can cite the research study on the US by Judith Blake, professor of demography at the University of California, Berkeley. The US has a death rate of 9 per 1000 and a birth rate of 18 per 1000. To achieve ZPG, the birth rate needs to be halved. To move towards this end three factors have to be taken into consideration: the timing of births within the reproductive period (do couples marry young, have children and stop or do they space their children out over the years ?), the number of women who are in the reproductive stage at a given time, and the total number of children per woman. An immediate counter-measure may be to enforce a massive postponement of births. But a postponement now will mean a subsequent boom in babies — a delayed reaction. The other solution might lie in restricting the number of births per woman. At present the average is three. This would have to be reduced to one per woman per reproductive lifetime. In the case of India, that would mean bringing the birth rate down 2·5 times! What lends the whole affair a little more feasibility in the US is the changing attitude to marriage and offspring. The marathon marrying habits of the 1940s and 1950s have slackened off. The 1950s' average of 159 marriages per 1000 in the age-group 15 — 44 has fallen to 144 per 1000. On the other hand, divorce rates have gone up—averaging an annual 38 to 40 per 1000. But all that is not enough to achieve ZPG.

At the current rates of mortality, it would take the US a minimum of 70 years to reach an age distribution among women to achieve ZPG. This is not all. Women would have to start immediately in cutting down the three children per family ratio to 2·1 children per family. The population would grow despite this to 280 million by 2040. If the process starts five years later, say around 1975, the population would be 290 million by 2040. This is a figure that doesn't take into consideration any sudden baby booms or backlashes or boomerangs. Seventy years is, however, too short a time for attempting such a largescale reduction in birth.

There is also the question of unwanted births. In one survey — the National Fertility Study — it was found that 17 per cent of all births in the US during 1960-65 among a sample of married women were "unwanted" by both parents and a further 22 per cent were unwanted by at least one parent. That works out to a median estimate of 7,50,000 births annually. But even if all unwanted births were prevented, the

natural increase in population would be reduced by only about 29 per cent.

Since that study, a further estimate shows that the percentage of unwanted births has fallen considerably. A deeper look into the question of unwanted births brings out certain aspects. Most unwanted births occur among Negroes, Catholics and the poorly educated. If a family planning campaign could clamp down on these groups, there would be an immediate hostile reaction. Cries of racism, anti-catholicism and class discrimination would be voiced. Which once again brings us up against the immutable fact — to achieve any progress in population control, it is essential to change the behaviour patterns of the people.

That means the age-old pattern of reproductive laissez faire should be modified to suit present conditions. But it isn't all that easy to become anti-natalist when state policies over the ages have always had a pronatalist complexion. Age-old beliefs are, however, in the process of erosion. Children are no longer always considered cheap or rewarding. Nor are they depended upon for labour or later economic support.

IN INDIA. Come back to India. Take another look. Here, population control is not merely an exercise in demography but an essential blueprint for the survival of future generations. All existing blueprints are faulty; their action and implementation have produced insufficient results.

Today India is in the second stage of the demographic cycle. The first stage prior to 1921 evidenced a balance between the birth and death rate, both high at that time, with a resultant stationary growth. In the second stage the births remained more or less stable but death rates dropped significantly due to improved public health services. The death rate has continued to fall and stands at about 18 per 1000. The third stage of the cycle involves a fall in the birth rate which narrows the gap and checks the growth of population. Western countries are in the fourth stage where both birth and death rates are sufficiently low. This stage, which they took 100 to 150 years to reach, has come through because of improved living conditions and a general acceptance and widespread adoption of family planning methods.

The crux of the problem in India is the discrepancy between birth and death rates. Experts say a woman married at 16 and living a biologically sound life with her spouse thereafter for a period of, say, 30 years, will in all

Who wants babies?

THE hijras (hermaphrodites) do. Not for themselves — that would be a biological impossibility — but for their livelihood. The hijras strongly protested against the government's family planning campaigns at one of their all India gatherings. To them babies mean money. They move from birthplace to birthplace collecting money from people who pay them willingly out of superstitious fears. Family planning involves a drop in business for them.

They are not the only disgruntled ones. There are others to whom babies mean big business—the baby products companies. Take a case study: the American experience. In 1970 there were 17·2 million children under five, a 15 per cent come-down from the 20·3 million 10 years earlier. This figure was in fact almost double the 8 per cent drop of the depression period of the 30s. And census figures show that decline is still the trend.

The infant shortage means fewer teens tomorrow and less married couples, middle-aged people and retirees later. The economy will react. In fact, the beginnings of reaction have set in. The American Hospital Association recorded an 8·4 per cent fall in the number of bassinets since 1963. School planners in many cities are scaling down their building plans. And even General Motors is having a second think on the number of station wagons it turns out in the years to come.

Then there are the ones who manufacture food, clothes and toys for the toddlers. They have already sensed the changes and have begun to diversify some into areas only remotely connected with infants. Some are making more goodies for fewer kids. Others are promoting their products for use by older children and even adults. For example, there is the Gerber Products Company that first made baby foods that would keep babies eating baby foods longer. They then catered to older infants. Eventually they diversified into baby accessories—waterproof pants, bibs, clothing items and eventually to baby insurance and can-making. They even changed their slogan to "babies are our business", dropping out the restricting "only". Johnson & Johnson have not been as subtle. Their baby powders have graduated for the use of anybody's "baby" and their TV commercial shows a shapely, freshly showered mother applying the powder to her limbs.

And, believe it or not, there is a blackmarket in babies! In many orphanages in Europe, bidders offer fantastic sums for babies they want to adopt. While the pressure on having less children mounts, the number of childless couples is staggeringly high. They want babies and are willing to pay. The baby business booms!

MILESTONES

Urban FP Centres	1,775	(ii) Sub-Centres	28,912
Rural FP Centres		(iii) Other rural medical centres doing FP work	7,427
(i) Main Centres	4,812		

Name of State/Union Territory	1969-70 (Reported up to 10th May, 1970) No. of IUCD insertions	Sterilisations
Andhra Pradesh ..	9,189	206,558
Assam	9,162	17,176
Bihar	35,619	66,965
Gujarat	10,648	94,308
Haryana	27,175	18,555
Jammu & Kashmir ..	4,379	7,415
Kerala	37,252	59,508
Madhya Pradesh ..	41,087	123,027
Maharashtra ..	8,500	228,000
Mysore	13,039	48,749
Orissa	37,342	102,278
Punjab	29,987	41,085
Rajasthan	22,430	43,530
Tamil Nadu	39,543	108,697
Uttar Pradesh ..	81,033	77,945
West Bengal ..	9,148	80,173
Nagaland	—	—
A. & N Islands ..	60	135
Chandigarh	526	438
Delhi	7,275	8,226
D. & N. Haveli ..	1	109
Goa, Daman & Diu	421	1,334
Himachal Pradesh ..	3,681	5,412
L., M. & A. Islands ..	3	32
Manipur	1,158	558
NEFA	55	21
Pondicherry ..	2,283	2,766
Tripura	329	3,979
Central Govt. Institutions ..	8,008	25,837
	439,333	1,372,816

Total IUCD insertions since July 1965 3,309,482

Total sterilisations since 1956 7,290,655

natural probability bear an average of 15 children. This is her reproductive potential. But the average rarely exceeds 10. The present average ranges from six to seven children per mother. And this despite the fact that Indian fertility is relatively low compared to that recorded in many countries. Only recently have fertility patterns in the advanced West and Japan fallen below the Indian norm. The full family complement in the West rarely exceeds four today. The differences in fertility are not governed merely by biological considerations but more so by cultural, social and other allied factors.

Take some facts available from limited sample surveys carried out in India over the last 15 years. The Indian woman who remains married right through her reproductive age brings into the world an average of six to seven children. This figure is not markedly influenced by geography. There is no significant differences in fertility levels of urban and rural populations. The urban areas are experiencing a welcome downward trend in the birth rate. The marriage age is still low in India though of late the tendency is to marry at a later age. Over the country, the mean age of marriage for girls was 13·0 years between 1901 to 1931. During 1931 to 1941, it rose to 14·9 years. In the next decade, the average was 15·4 years.

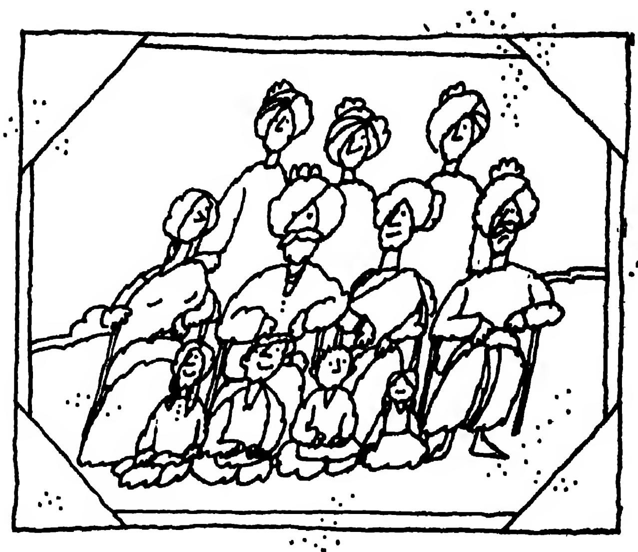
The trend has become inevitable. Tradition and community opinion are gradually bowing to economic and social conditions. Women are marrying later, a trend especially noticeable among the richer classes of society. But theoretical calculations and projections show that fertility will not be reduced to any marked degree by these changes in marriage age. Another factor which at one time was a boon to the static birth rate was widowhood. Now, because of less deaths, widowhood is less common. Also social attitudes have changed with reference to widow remarriages. This tends to increase fertility by about 15 per cent. There are other social and cultural factors. The average time lag between consecutive births as shown in the fourth round of the National Sample Survey is 34 months for urban couples and 32 months for their rural counterparts married after 1930.

FAMILY PLANNING. The declared objective of the state is to reduce the existing birth rate from 41 per 1000 to 25 or even 20 per 1000 in as short a time as possible. But how does one go about it ? 548 million people.

More than 70 per cent still not literate. Of the 105 million odd couples, 90 per cent in the reproductive age group. Seventeen states, 11 union territories, 326 administrative districts, some 2,690 towns and cities and 564,258 villages. Fourteen major languages, 200 odd dialects. How does one tell this overwhelming heterogeneity not to procreate, not to have more than one or two children ?

A massive programme. Campaigns to make 'family planning' a household phrase. The red triangle on every street corner. What have we achieved ? Look at the figures. Total sterilisations in the country since July, 1956 till May 1970: 7,290,655. Total IUCD insertions since 1965: 3,309,482. Total number of conventional

(Contd. on page 16)



ABORTION

THE Medical Termination of Pregnancy Act, 1971, which received the assent of the President of India in August last year, came into force on 1 April, 1972.

According to the Act, a pregnancy may be terminated by a Registered Medical Practitioner if such a practitioner is of the opinion, formed in good faith, that --

(*a*) The continuance of the pregnancy would involve a risk to the life of a pregnant woman or a grave injury to her physical or mental health, or

(*b*) There is substantial risk that if the child were born, it would suffer from such physical or mental abnormalities as to be seriously handicapped.

Where any pregnancy is alleged by the pregnant woman to have been caused by rape, the anguish caused by such pregnancy shall be presumed to constitute a grave injury to the mental health of the pregnant woman. Also, where any pregnancy occurs as a result of failure of any device or method used by any married woman or her husband for the purpose of limiting the number of children, the anguish caused by such unwanted pregnancy may be presumed to constitute a grave injury to the mental health of the pregnant woman.

If the period of pregnancy is under 12 weeks, only one registered practitioner may perform the abortion, but if the pregnancy has gone beyond 12 weeks, at least 2 doctors must opine on the need for abortion. The law does not ordinarily apply to pregnancies beyond 20 weeks.

A Registered Medical Practitioner as defined by the law is a doctor who "possesses any recognised medical qualification as defined in Clause (*h*) of Section 2 of the Indian Medical Council Act, 1956, whose name has been entered in a State Medical Register and who has such experience or training in gynaecology and obstetrics as may be prescribed by rules made under this Act." It is therefore obvious that those trained in the ayurvedic, homoeopathic and unani systems of medicine cannot conduct abortions.

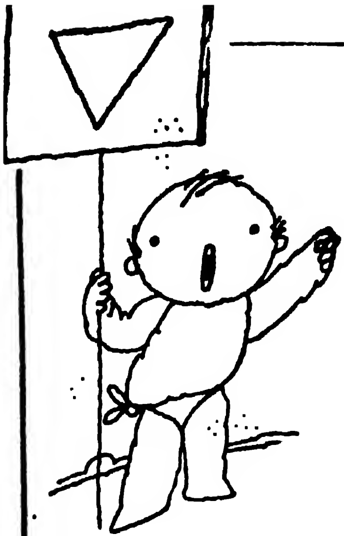
Pregnancies can be terminated only at recognised centres like government hospitals which have the necessary facilities and equipment or those private hospitals which are approved by the Government for this purpose. Strict professional secrecy will be maintained.

Every woman must give her consent in writing if she wants an abortion. If she is a minor or of unsound mind, a guardian can give this. The consent of the husband is not necessary.

Special provisions have been made under the Act to cope with emergencies. To save the life of a pregnant woman, termination of pregnancy is permitted even after 20 weeks of pregnancy and without a second opinion from another doctor. Under these circumstances it is allowed even in private hospitals which are not recognised by the Government for the purpose and by doctors who do not have the required experience or training.

Whether these special clauses will lead to dangerous situations and whether they will need future amendment, only time will show.

What the present law does not state is how many times a woman can get herself aborted, whether she must get herself completely sterilised afterwards and whether a competent doctor can refuse to do it. An uniform fee for all such abortions when done in private hospitals is also to be considered.



how not to make babies

R. P. SOONAWALA

ALL over the world, scientific advance has curbed the death rate — better medicines, better health, longer life. But that upsets the balance. If people don't die while babies keep being born, soon the earth will be a jam-packed hell-hole. Where is the way out ? You can't let people die if the deaths can be prevented — that is morally inconceivable. Then, stop the births ? Exactly.

The technology of contraception has grown in the last three decades. The methods can be categorised into those for spacing pregnancies and those for limitation when the family is complete.

Methods for spacing

1. Home-made methods
2. Non-appliance methods — Rhythm
   — Coitus interruptus
3. Mechanical barriers
4. Chemical barriers — Spermicidals
5. Hormones — Oral Contraceptives (Pills)
6. Intra-uterine Contraceptive Devices (IUCD)

Methods for limitation

1. Vasectomy in males
2. Tubal ligation in females.

The home-made methods, in use for generations, consists of taking a douche (wash) immediately after coitus or placing a sponge or strip of cloth dipped in oil in the depth of the vagina so as to cover the mouth of the uterus (womb). The drawbacks of these methods are a high failure rate and high incidence of sepsis.

In the non-appliance methods, coitus interruptus or what is commonly known as withdrawal (before ejaculation) has been practised by the human race for many many years. Early withdrawal produces tension and is most unsatisfactory for the female partner besides its high failure rate (because even the normal male secretions may carry the sperm).

Around 1936, research in reproductive physiology unfolded the mechanism of ovulation and the time in menstrual cycle when ovulation took place was precisely known. It was then that the **Rhythm Method** came in. A woman produces only one ripe egg per month. The egg remains alive only for 24 hours and must be fertilised by a sperm within that time. Since a sperm can remain alive for 48 hours, that means a woman can get pregnant only during this 72-hour period in a month. In a woman with regular menstrual cycles of 28 days, the ovulation takes place on the 14th day from the start of the previous menses. Because 48 hours or two days have to be added to provide for the margin of safety from the sperm's side, the time between the 11th and 17th day is considered to be the fertile interval. To make this calculation easy and applicable for mass use, beads of two colours — green and red — were tried but did not prove very useful. Of late, there is a simple way to determine when ovulation occurs by using a strip of litmus paper which changes colour according to the acidity of the vaginal secretion and pinpoints the day of ovulation. Since the Roman Catholic Church does not advocate the use of any method of contraception where an appliance is used, coitus interruptus and rhythm are the only methods allowed to be practised. However, the high failure rate creates a fear of pregnancy leading to tension and dissatisfaction.

The mechanical barriers used by the male are called the condom. In the days of the Roman Empire when veneral diseases were rampant, Roman physicians advocated the use of condom made out of cloth. But since it was not an effective barrier, condoms made out of intestines of sheep came into use. Later rubber and latex were the materials used in manufacture of condoms ; now they are made mostly from plastic polyethelene films.

The mechanical barriers for the female are caps which fit the mouth of the uterus — cervical cap or a cap which fits the upper part of the vagina (called the vault cap) or the diaphragm which fits diagonally. Amongst these, the diaphragm is the most popular, though used by itself is unsatisfactory as failure rate is high. It is always used in conjunction with spermicidal jelly to bring down the chances of failure.

The chemical barriers are spermicidal chemicals which come in the form of tablets, jellies, pastes or creams which are lethal to spermatozoa. Although an old method, it has never become very popular because of high failure rate, the local irritation it may cause to both the partners and they are very messy when used.

Lately, aerosol dispensers have been introduced to make application of the spermicidal easy. The Drug Research Laboratory at Lucknow has observed that urea — a waste product of the human body excreted by the kidney — is an effective spermicidal. Urea in the quantity required is harmless and non-irritant to the tissue as compared to the other spermicidal agents. It is under clinical trial in the form of a film of gelatine coated with urea. It is like a large postage stamp and is called Centsquare. If found satisfactory and effective, it would be a big breakthrough.

The Pill or oral contraceptive is a method in use since 1956. The pill consists of female hormones similar to those produced during pregnancy. It prevents ovulation and changes the quality of uterine secretion thus averting pregnancy.

There are various types of pills available for a short-term use and for spacing of pregnancy. It is a very reliable method provided the woman is particular and takes them regularly without lapse. In some women, the pill may cause side-effects like nausea, weight-gain, scanty periods, etc but the majority are able to use them. The complication of coagulation of blood leading to thrombosis in veins is luckily not so commonly observed in the tropics as in the western countries where due to the cold climate, vascular diseases are more common.

The thrombo-embolic phenomenon had caused a great scare. Young women on pill started getting thrombosis and this in a few was even fatal. Investigation showed that the pills which contained high doses of oestrogen hormone were more prone to produce this complication. Hence all pills with high dose of oestrogen — more than 0·05 mg — were withdrawn from the market by the Drug Control Department.

To overcome the monotony of taking a pill every day, an injection of the hormone in oil to serve as depot has been used and its effect lasts for nearly three months. To extend the time still further, the hormone is loaded in a silastic tube and implanted under a deep layer of the skin. This silastic tube allows the hormone to be released slowly and its effect lasts for a couple of years. When a pregnancy is desired, the implant is removed and fertility returns.

Attempts have not been so successful in developing a pill for the male. The pills tried out so far led to impotency, and another compound gave a violent reaction if alcohol was taken.

The intra-uterine method of contraception has been known since 1880. The most popular intra-uterine device available at the moment is Lippe's loop. This method of contraception is ideal as its effect is in the uterine cavity and not on the whole body. After it is introduced, it is expected to protect the woman for about 2 to 3 years or even more. However, the irregular bleeding it caused and poor follow-up have brought the method into disrepute.

The IUCDs are available in different shapes, sizes and are made of nylon, polyethelene, silver, gold, stainless steel, silastic, etc. Yet no ideal size or material has yet been found. A large IUCD prevents pregnancy but causes bleeding, while with a small IUCD, bleeding is negligible but failure rate is high. In 1970 it was noticed that presence of copper wire on the IUCD reduces chances of failure remarkably even if the IUCD is small. Now under trial is *T* Cu — a small-size IUCD made of polyethelene with a copper wire wound round it. This may give a very promising breakthrough.

Although from time to time opinions are voiced that IUCD or the Pill may lead to development of cancer, so far none of these have been proved. Cancer of the breast and genital organs is a rather common condition and some women may develop them irrespective of the contraceptive.

Once the family is complete and no more children are desired, one can go for actual surgical procedure — **vasectomy** for the male or **tubectomy** for the female.

In vasectomy, the duct which carries the spermatozoa from the testicles to the storehouse is ligated and cut. After 6 to 8 ejaculations, the stored spermatozoa are used up and no fresh sperms are added and the seminal fluid becomes infertile. In the scrotum, the vas is just under the skin and can be approached easily. The operation takes 5 to 10 minutes and is done as an outdoor procedure under local anaesthesia. If a reversal is desired at a later date to restore reproductivity, the vas can be anastomosed (rejoined).

The only disadvantage of vasectomy is that since the male has not to bear the hardship of child-bearing and upbringing, he is less motivated and is reluctant to go for it. Although potency and fertility are two completely separate entities, psychologically they are always put together and the false fear of loss of potency remains erect as a barrier in the minds of many men.

Tubectomy, however, involves major surgery. The tubes are approached by an incision on the abdomen (abdominal tubectomy) as is commonly done soon after delivery. In other cases, the tubes are ligated by making a small cut at the vault of the vagina. A decade back, the vaginal approach was dreaded by surgeons and gynaecologists as it was thought to be very difficult. But changes in technique and availability of better instruments has made it a very simple procedure now. Also, this way the pain is less, the risk of hernia is less and the patient can safely go home before 72 hours.

To cut down the hospital stay to one day and make tubectomy apparently easy, two special instruments called laparoscope — for the abdomen and culdoscope — for the vagina, are used. In these the tubes are visualised and caught with special forceps to be cauterised and blocked by application of clips. These are highly sophisticated methods and not practical under the conditions we have to work in. Of the two, culdoscope is easier to handle than laparoscope.

Reversal of tubectomy can be attempted but the success rate is still disputed. ■ ■

[Dr. R. P. Soonawala, a consulting gynaecologist and obstetrician, is technical adviser to several family planning clinics in Bombay. Creator of the well-known Soonawala IUD, he wrote on "Family Planning and the IUD" in the October 1968 issue of SCIENCE TODAY.]

(Contd. from page 13)

contraceptive users in one year (1969-70): 1,428,060. Say, roughly, 12 million people. Now recall what is our grand total. Or look at it another way: of all the couples in the country in the reproductive age group, by March 1970 only 11·8 per cent had been protected by sterilisation and a meagre 2·8 per cent by IUCD or a total of only 14·6 per cent.

A disheartening percentage, that one! What has gone wrong ? Or is it that our hopes were coloured by exaggerated optimism ? Human beings are not automatons that can be fitted with varied apparatus and left to function faultlessly. The use of contraceptives may have side-effects. Contraceptives may fail. There may be psychological barriers to their use. What happens inside a couple's bedroom cannot be predetermined by legislation or social planning. The initial resistance has been overcome by now — the mass media have done their job to some extent. Religious taboos are breaking down, even among the Catholics. Abortion has been legalised. Yet, despite these, not even one-fifth of the country's reproductive couples have been protected.

THE MALADY lies in our thinking, in our failure to adopt a policy that will be relevant for the whole nation. On the one hand there is the official apathy towards anything new. Take for instance the recent development of intra-uterine administration of progesterone. This device is said to almost totally eliminate the margin of error in IUDs. An Indian gynaecologist who had participated in its development work in Chicago and has presented three papers on it claims that its efficacy has been accepted by several authorities. Some international agencies had requested her to prepare 1,000 capsules for international trials. Though several months have passed, she has not been given the necessary permission to start work.

The other side of the coin is the lack of sensitivity — everything we do is in terms of just the numbers. Each clinic, each family planning worker works to fulfil a target and the motto is " grab them and give them ". Any long-term contraceptive procedure is a medical job and the individual has to be treated as an individual, not as one of a herd. Each case has to be reviewed before a man's or a woman's body can be tampered with and there has to be a follow-up because lots of things can go wrong. How do you achieve that when you are dealing with tens of millions?

Is the Pill Safe?

THE ' pill ' has become an important milestone of our time. It has not only played a significant role in lowering birth rates and thus controlling population, but it has also brought about a sociological change in the attitudes and behaviour patterns of the people particularly in the western society. How safe is it ? This is a question that has been asked time and again ever since the pill was marketed.

Much research and documentation have gone into the problem of the so-called ' side-effects ' of the pill. The topic is still controversial and admits of much more study, both clinical and experimental.

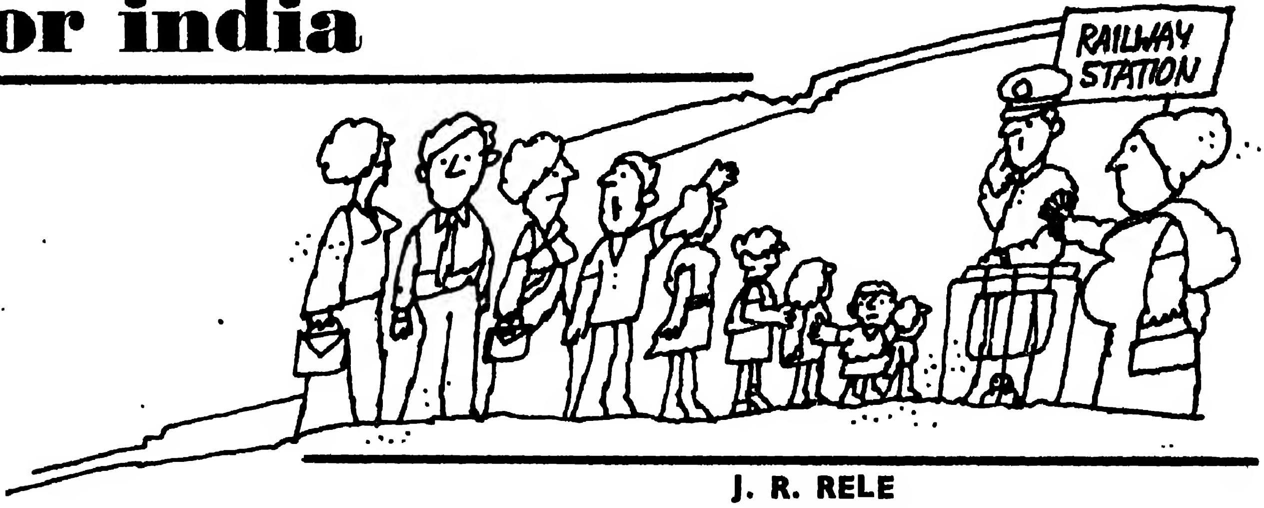
What has however been established without doubt is that the major risks of these pills — blood clotting, liver damage, etc depend upon their oestrogen (one of the female hormones) content. With lower than ·05 mg oestrogen, the fatality risks are very much less than those from all contraceptives and also from all other attributable causes associated with child-bearing like complications of pregnancy and delivery. With doses over ·05 mg of oestrogen, the risks rise proportionately.

Indiscriminate prescribing of oral contraceptives is to be shunned. In women who are grossly overweight and heavy smokers, who have high blood pressure, a high level of cholesterol in the blood, diabetes and a strong family history of occulsive disease of their blood vessels, varicose veins, jaundice in a previous pregnancy etc, oral contraceptives must be recommended with reserve. It is also established that these risks increase with the age of the woman.

Victor A. Drill from the Division of Biological Research, G. D. Searle and Co. and the University of Illinois School of Medicine, Chicago, in a paper read before the second annual meeting of the Family Planning Association of the Americas, Los Angeles, in October 1970, has put forward different views. He states that the average normal incidence of superficial and deep vein thromboembolic disease in women of child bearing age is 2·2 cases per 1,000 women per year. The incidence of this disease is not increased when oral contraceptives are employed. Although retrospective survey studies have provided the hypothesis of increased risk in women taking oral contraceptives, this hypothesis is not confirmed by the large volume of prospective studies now available. These studies also show that there is no relation between disease and dose of oestrogen. At all doses of oestrogen, the incidence of thromboembolic disease was not greater than the average normal rate of 2·2 cases per 1,000 women of child bearing age per year.

M. N.

a population policy for india



J. R. RELE

INDIA, the second largest country in the world in population size after China, enumerated the total population of 548 million in the recent census of 1971. This amounts to the population density of 182 per square kilometre, as against 75 for Asia, and 27 for the world as a whole. And the population has been growing at an accelerated rate. The annual rate of growth during 1961-71 was 2·3, which was higher than 2·0 in 1951-61 and 1·3 in 1941-51. It is already clear that, left to itself, the growth after a few decades will amount to an explosion. Can we prevent it ? The answer is, we must. How, is a matter of policy, but let us first understand the perspective.

The rapid growth of population in India is not an isolated phenomenon. Currently the total population of the world itself is growing at an unprecedented rate of 2·0 per cent per annum. The main contributing factor to this rapid growth is the declining mortality in all the developing nations, especially during the last half century. Yet the nature of the problem now faced by the developing nations is quite distinct and different from that ever experienced by the developed countries. The difference stems from the characteristics of the falling death rate. In the first place, in the developed countries the mortality decline appeared as a part of the developing process itself. It was a by-product of scientific and technological development which led to the discovery of means to control specific diseases. It was geared to the extension of the frontiers of knowledge, and by its very nature was a slow process. On the other hand, for the developing countries the scientific knowledge for the control of various diseases was already in existence, and it was merely a question of transplanting this knowledge on the new soil. When that was done, the result was dramatic — a steep decline in mortality. This has been the primary cause of the current spurt in population growth throughout the developing nations. In India, until 1921, mortality was high and fluctuating, and kept the population in check. After 1921, the death rate took a steep drop (See the crude death rate in the Table, p. 18) and population figures have had a happy ride ever since.

EXPERIENCE FROM DEVELOPED COUNTRIES. The developed countries too had a phase of rapid population growth during their initial stage of mortality decline, but the rates of growth were far less than those currently prevailing in the developing countries. This was for two reasons. First, as mentioned earlier, mortality decline was slower in the developed countries than it is now in the developing countries. Secondly, the birth rate in the developed countries in the pre-industrial era was substantially lower than that prevailing there now. More significantly, the phase of rapid growth of population in the developed countries was initiated by economic and industrial development, so that the growing economy could not only absorb the additional population, but was even assisted by it. But growth of population was not excessive, mainly because the very

Table : VARIATION IN POPULATION, ANNUAL RATE OF GROWTH, BIRTH RATE AND DEATH RATE IN INDIA DURING 1901-71

Year	Population	Annual Rate of Growth	Birth Rate	Death Rate
1901	238,396,327			
		0·56	49·2	42·6
1911	252,093,390			
		— 0·03	48·1	47·2
1921	251,321,213			
		1·04	46·4	36·3
1931	278,977,238			
		1·34	45·2	31·2
1941	318,660,580			
		1·26	39·9	27·4
1951	361,088,090			
		1·98	41·7	22·8
1961	439,234,771			
		2·3		
1971	547,367,926			

economic and industrial development which brought about decline in mortality in the developed countries was also eventually responsible for the kind of social transformation which reduced the birth rate. The birth rate fell as a response to the changing social milieu.

The growth of industrialisation had a two-fold effect on the population distribution. On one hand, in the rural areas, with the agricultural revolution and mechanisation of farms, less people were required for cultivation on the land. On the other, the industrial revolution made it possible to absorb this excess population liberated from rural areas in the urban industrial centres. There was a movement of population from rural to urban areas. The problems of urban dwelling affected the family unit, and changed its functions to suit the changing environment. The mobility itself supported this change by providing a break from traditionalism.

The distinctive feature of the urban way of life was that it was more achievement-oriented in contrast to the rural ascriptive society. The process of social change in general, which followed urbanisation, was assisted by the growth of opportunities as well as rising standards of living. With opportunities, aspirations rose, and as these came progressively within the reach of the common man, there was a strong motivation to rise up the social ladder. In this effort, every additional child became a burden to the family in its upward social mobility. Also, the industrial society required greater skills and preparation for children to enter into higher occupations which were opened up to everyone on the basis of merit. The higher expectations of training and standards of living of children led to the rise in the cost of rearing a child, so that every child had to be carefully planned. The growth of economy provided jobs suitable to women, which modified their erstwhile role of housekeeping and bearing and rearing of children. With the availability of social security benefits against unemployment and retirement, children were not required to provide for the old age of the parents. This reduced the sex preference among the off-springs — the emphasis on having a son. With this kind of transformation of the economic and social patterns, needs and behaviours, the individual couples by themselves decided to control their family size, which reduced the fertility at the national level.

The experience of the developed countries thus tells us that the key factor to the reduction of fertility in those countries was individual motivation to control family size, which arose as a consequence of economic development. However, in the developing countries like India today, the economic development itself tends to be threatened by rapid population growth. In fact, it has become a vicious circle. The success of a population policy in India thus would depend on how well it is able to break this vicious circle. The developed countries never had this problem, and there is no possibility of having a readymade solution to the problem based on their experience. The problem of India and other developing countries is new, and by its very nature will require a fresh solution.

THE STATE AS MOTIVATOR. In trying to find an answer to this unprecedented problem, a number of developing countries like India have launched national family planning programmes, and still others have no official programmes but have supported family planning activities. Together they cover 81 per cent of the total population of the developing countries. The objective of these programmes is to reduce the birth rate as expeditiously as possible to control the growth of population. In India, the family planning programme had its beginning as early as 1951 along with the First Five Year Plan. The programme has emphasised at various stages different means of contraception like foam tablets, condoms, IUCDs, and male and female sterilisations, and has attempted to popularise them among the eligible couples. However, in spite of these concentrated efforts for over two decades, their effect on the birth rate so far has been rather negligible. The essential reason for this limited success of the family planning programme is that the programme is effective in providing the means to control family size to couples who are already so motivated, but has little or no control over those who are either indifferent or see no advantage under the present conditions of living to limit the number of their children.

Thus an important requirement of a national population policy would be to promote conditions so that large family size would be economically and socially disadvantageous to individual couples, and would be deemed undesirable. If the conditions of life sufficiently motivate individuals to have less number of children, they will control their family size with or without family planning programmes. In such a situation the family planning programme could be effective in providing the means to the already motivated couples, and could succeed in expediting the change towards a lower fertility. The experience of some countries in the East, like Japan, Republic of Korea, Singapore and Taiwan, has shown that when the social and economic conditions reach the stage of favouring reduced fertility, the family planning programme yields miraculous results with a sharp and sustained decline in the birth rate.

THE motivation to limit the family size can be best brought about by economic development. Since economic development itself is hampered by population growth in India, let us examine and isolate the various aspects of economic development that are likely to have more direct relevance to family size norm. By exercising control over these aspects it may be possible to place an indirect constraint on the size of a family. The factors which are amenable to such control are, for instance, age at marriage, education, urbanisation, social security and employment of women. It is also possible to think of a wide variety of other economic and social changes which could contribute towards reduction of fertility. A common link in most of these is a change from an ascriptive to an achievement-oriented norm in varied spheres of activities. That is also precisely the change that is involved in a transition from higher to lower level of fertility. At the higher level of fertility marked by indifference, the number of children are merely ascribed to fate or the Will of God. At the lower level, it is the individual who decides the number.

The point can be elaborated further. The change must come in the context of educational and administrative subsystems in India where it is most urgent and is likely to have the most widespread impact. The argument can be extended to other subsystems of the society as well. " Achievement " in the educational system in India is mainly confined to getting grades and divisions rather than knowledge. Once these divisions are obtained, they reduce to mere ascribed characteristics, which can be used for advantage or disadvantage for the rest of the life. In short, the division in the final examination promotes a parallel " caste system " in our education, which is sufficiently rigid to determine forever an individual's station in life. Again in the administrative system, our bureaucratic structure often ascribes an individual to a position in the hierarchy, and has little appreciation for individual achievement. What is needed is a more flexible system which can promote the sense of achievement and responsibility. The Indian society which is now preaching responsible parenthood should also promote responsibility in other spheres of life.

Dr. Rele is Professor and Head of the Teaching Division at the International Institute for Population Studies in Bombay. Statistician, demographer and sociologist, Dr. Rele took his Master's degree from the Bombay University and his PhD from the University of California, Berkeley, where he had worked with Professor Kingsley Davis for five years. Author of several scientific papers and books, Dr. Rele's article on " Population Problem in India — a World Perspective " had appeared in the January 1968 issue of SCIENCE TODAY.

---

round-up of research

SURGERY

By-passing the Diseased Coronary Artery

THE incidence of coronary artery disease continues to increase. The causes suggested include a family history of the disease, high blood pressure, smoking, physical inactivity, obesity, diabetes etc. Others like carbon monoxide in urban air, diet with a low fibre content, and soft drinking water have also been suggested. In this disease, there is a narrowing or blockage of one or both of the coronary arteries, which supply blood to the heart muscles. Spasms or narrowing of these vessels produces angina pectoris.

In the past many operations devised to improve blood supply to the heart were unsuccessful. However, in 1967 a new operation known as venous by-pass graft technique was developed by Drs. D. B. Effler and R. G. Favaloro at the Cleveland Clinic, Ohio, USA. This technique involves placing a length of vein taken from the patient's leg between the aorta and the coronary arteries away from the diseased portion, so as to by-pass the blocked or narrowed section. (Aorta is the main artery arising out of the left ventricle of the heart and carrying purified blood from it ; the coronary arteries are the first pair of blood vessels to be given off by the aorta as it leaves the left ventricle.) One or several grafts may be necessary, depending on the extent of the disease, and the success of the technique depends on the accurate location of the obstruction in the coronary arteries.

The new operation has already earned a name for the relief of angina pectoris persisting even after full medical treatment ; it is undoubtedly the most effective means of improving blood supply to the heart muscles. The grafts have now been observed to remain open for as long a period as three years after the operation. The apparent success of the technique has led to the performance of large numbers of by-pass operations in America. Nevertheless, caution has been advised in some quarters since a careful assessment of the results, including that of left ventricular function under controlled conditions, is necessary before the true place of the operation in the treatment of angina pectoris can be defined. A team of 10 London based doctors led by Dr. Donald Ross now report in the *British Medical Journal* (*2*, **644**, 10 June 1972) their experiences with aorto-coronary venous by-pass graft operation on 67 patients with an objective assessment of left ventricular function.

Since the surgical technique was new, only patients who had severe coronary heart disease in spite of optimal medical treatment by other means were accepted by the doctors for operation. Of the 67 patients, 57 had angina pectoris (pain on slight exertion), two had a malfunctioning of the left ventricle of the heart, whereas the other eight were emergency operations after acute heart attacks. The investigations before the operation included an electrocardiogram, chest radiography, blood count, urine analysis, estimation of serum cholesterol and a check on the functioning of the auricles and left ventricle of the heart. During the operation, 18 patients were given a single venous by-pass, 41 two venous grafts, and five three venous by-pass grafts.

After the operation, eight of the 57 patients with angina, one of the two patients with left ventricular malfunction and four of the eight emergency operations died ; the overall mortality was 15·8 per cent. It was found that the mortality rate was low in patients without previous heart attacks and with normal left ventricular function.

The survivors of the operation were watched for a period of 3 to 27 months. In as many patients as possible angiography was performed to test the opening of the venous grafts. Further, electrocardiograms were taken and left ventricular function measured on suitable surviving patients, and the results compared with conditions before the operation, and as a function of venous graft openings. It was found that altogether 67 per cent of the survivors were symptom-free and 89 per cent had improved their heart condition.

The British doctors conclude that the operations have shown benefit in severe angina pectoris cases in terms of the relief of symptoms and objective improvement of left ventricular function correlating with the opening of venous grafts.

DRUGS

Rifampicin Tames Tumours in Hamsters

RIFAMPICIN, a derivative of rifamycin has an extraordinarily wide spectrum of biological activity. It not only inhibits bacterial growth both *in vitro* and *in vivo*, but is also active against some viruses *in vitro*. For example, it inhibits the trachoma agent in embryonated eggs *in vitro* and in monkeys *in vivo* (see SCIENCE TODAY, January 1970, p. 23), and selectively blocks replication of vaccina virus in cultured mouse cells. Studies have indicated that the drug even inhibits malaria in mice, and is useful in the treatment of human tuberculosis. Further, though the drug is not toxic to all the DNA and RNA viruses, it inhibits the growth of poxvirus and certain types of adenoviruses. Adenoviruses are known to cause infection of the upper respiratory tract, pneumonia, tumours and epidemic conjunctivitis.

Drs. H. W. Toolan and N. Ledinko of Putnam Memorial Hospital, Institute for Medical Research, Bennington, Vermont, USA, have now reported in *Nature New Biology* (*237*, 200, 14 June 1972) the role of rifampicin in inhibiting the development of tumours induced by adenovirus in hamsters.

Toolan and Ledinko performed a set of experiments in which they injected newborn male and female hamsters with a dose of the tumour-causing adenovirus and followed it with a series of injections of rifampicin in two doses, large and small. The virus used in the experiments was grown in human embryonic kidney cell cultures and fresh preparations of rifampicin diluted in saline were prepared each week. Control animals were injected either with the virus alone or with the drug alone or with saline. The number of animals of both sexes subsequently developing tumours, and the time at which tumours first became detectable, were then measured. Further, when the hamsters were 15 weeks old, they were killed and autopsied.

It was observed that several hamsters which were given large doses of rifampicin were dead within four weeks, presumably due to the toxicity of the drug ; female deaths were twice as many as males. Further, the first tumours appeared in the females when they were between four and five weeks of age, whereas in the males tumours were first seen between the sixth and seventh week. The experiments revealed that female hamsters are significantly more susceptible to the tumour action of adenovirus than are their male litter mates, and rifampicin, if anything, enhances the susceptibility of female hamsters. By contrast, the drug even in the small dose used in the experiment significantly reduces the incidence of tumours in baby male hamsters inoculated with adenovirus ; the tumour incidence in the treated males was 9 per cent, compared with 32 per cent in the untreated controls.

The reason why rifampicin affects the induction of tumours by adenovirus in male hamsters and why female hamsters are more susceptible to the oncogenic action of adenovirus are at present unknown.

SELENOLOGY

What's the Inside of the Moon Like ?

A TEAM of 11 American scientists led by Dr. Gary Latham, Seismologist of the Lamont-Doherty Geological Observatory, Columbia University, Palisades, New York (USA), has reported in *Science* (*176*, 1012, 2 June 1972) the details of the structure and composition of the Moon's interior to a depth of about 100 km. The information was obtained from seismic data recorded by the seismometers left on the moon by the Apollo astronauts.

The seismometers were set up by the crews of Apollo-12 on the Ocean of Storms in November 1969 ; by Apollo-14 in the Fra Mauro region in February 1971 ; by Apollo-15 at the Hadley Apennine site in August 1971 ; and by Apollo-16 at Descartes on April 21, 1972. All these stations are nuclear-powered and are on the Moon's side which always faces the Earth. The seismic data recorded by these stations are transmitted to Earth.

The American scientists in their investigation used the seismic data recorded by the Apollo-12, 14 and 15 seismometers on impact of the burnt-out Saturn (S-IV B) rocket and the lunar module (LM) ascent stage during the Apollo programmes.

The signals resulting from the impacts had the same general characteristics and the scientists picked up the signals corresponding to the arrival of discrete seismic phases at each station from the early parts of the seismic records. From these, the travel times, amplitudes and wave shapes of the compressional (P) waves were obtained for distances between the source of impact and the stations. The data were then used to determine the seismic velocity structure of the lunar interior. The composition of the interior was determined using the results of high-pressure laboratory measurements on lunar and terrestrial rocks of various types ; these measurements measured the velocities in rocks as a function of pressure.

The main results of the study were : (1) The Moon has a very low seismic velocity near the surface (starting at 0·1 km/sec) corresponding to lunar fines (soils) and broken rocks. (2) The measured velocities ($\sim$5 km/sec) below a few km are characteristic of lunar basaltic rocks to a depth of 25 km. However, it is not possible to rule out other compositions or rock types that may have similar velocities in a environment. (3) A sharp increase in velocity (discontinuity) occurs at a depth of about 25 km. (4) The nearly constant velocity (6·8 km/sec) between 25 and 65 km corresponds to a composition of anorthositic gabbro or gabbroic anorthosite, although other interpretations are be possible. (5) A significant and discontinuous increase in seismic velocity occurs below 65 km. From comparison with velocities characteristic of the Earth's crust and mantle it is appropriate to define the base of the lunar crust at 65 km. (6) Below the lunar crust the apparent seismic velocity is about 9 km/sec. However, the determination of the structure and composition of the mantle regions requires more seismic data.

In short, the Moon has a layered structure like the Earth, with a crust and mantle. The boundary between the crust and mantle occurs at a depth of 65 km.

ENTOMOLOGY

Copying Has Its Advantages

THEORIES on protective mimicry in insects by H. W. Bates (1862) and F. Muller (1879) were the first models suggesting evolution of monomorphism and similarity between species under the influence of Darwinian natural selection. In Batesian mimicry a rare edible species of an insect may come to resemble (mimic) a common inedible species, since predators will learn to avoid the inedible insect, and subsequently the mimic. In Mullerian mimicry two or more inedible species will obtain an advantage by resembling one another, since predators will only have one pattern to learn and more insects to learn from. The above theories were deduced from limited empirical evidence and have not been thoroughly tested so far.

Dr. W. W. Benson of the Department of zoology, University of Washington, Seattle (USA), by experimenting on a species of butterfly known as *Heliconius erato* has now obtained direct quantitative evidence to support the hypothesis that natural selection promotes the evolution of mimicry. The results of his experiments reported in *Science* (*176*, 936, 26 May 1972) further support the hypothesis that Mullerian mimicry was functioning to protect the butterflies from predators.

The species *H. erato* inhabits the Central American tropical wet forest. It is inedible to birds that prey on butterflies and shares its native habitat with more than one equally inedible mimic. For example, the middle American race *H. erato petiverana* shares its wing patterns with the race *H. melpomene rosina.* In addition to looking alike, the two species behave similarly, thereby suggesting *a priori* that the mimicry between these two species is functional.

Individuals of *H. erato* roost regularly, often during their entire life, at the same place overnight. This enabled the American zoologist to catch and mark individual butterflies and to examine them on subsequent nights. In his experiments, he altered the natural colour pattern of certain individuals in *H. erato* population by staining a red band on their front wings black. Controls were produced by staining an approximately equal number of butterflies black on their already black wing tips, thus effectively leaving the wing pattern unaltered. The altered butterflies served as artificially produced non-mimics whose survival could be compared under conditions of natural selection with that of the controls.

Dr. Benson then measured the 'residence time' (minimum longevity) and major wing damage due to attack by birds in the population. In experiments conducted during 1968, he found that the altered butterflies survived for a significantly shorter period of time and received

more wing damage than the controls, presumably because the birds did not recognise them as inedible.

The American scientist, hence, concludes that the results of his experiment are consistent with the Mullerian hypothesis and demonstrate that natural selection operates to maintain uniformity in the population. It follows that a rare species of inedible butterfly will suffer greater mortality unless it imitates the colour pattern of a more abundant species.

PHYSIOLOGY

Sleeping the Sleep of the Just

VERY little research has been done so far onthe relation between nutrition and sleep. It is the traditional belief of many that a hot drink at bed-time helps them to sleep better. Two groups of psychologists in Britain have now made an objective study of sleep after taking Horlicks, a milk-cereal powder which for several generations has been claimed to promote good sleep. The results of their study reported in *British Medical Journal* (2, 429, 431, 20 May 1972) confirms the popular belief, but the methods used in the studies are now being challenged by others.

In the first investigation, Drs. P. R. Southwell, C. R. Evans and J. N. Hunt of Guy's Hospital Medical School, London have compared the effects on sleep of a hot drink of milk mixed with Horlicks with that of hot water taken before retiring by four medical student volunteers. The students slept between 11 and 11-30 p.m. and 7-00 a.m., and the scientists measured their movements during sleep by time-lapse cinematography with a 16-mm camera. When the records from 1 to 7 a.m. were analysed it was observed that Horlicks gradually reduced with time the number of small movements involving hands, foot etc, but not larger ones like turning the trunk, made during sleep. The scientists conclude that since it is unlikely that Horlicks will remain in the stomach for more than three hours after intake, it is possible that it provides amino-acids which are converted into neural transmitters and influence the central nervous function; or the response could in some way be associated with the fat in milk.

In the second investigation, Drs. V. Brezinova and I. Oswald of the Department of Psychiatry, University of Edinburgh, have compared the effects of Horlicks on sleep with those of a placebo. According to them, the methods adopted by Dr. Southwell and his colleagues do not allow discrimination between movements made while asleep and during episodes of wakefulness. Their study was made on 10 young adults of mean age 22 years and 8 old adults of mean age 55 years. Older people were studied since it is known that broken sleep is an accompaniment of normal ageing. Each subject slept in the sleep laboratory for 10 nights. On five laboratory nights, Horlicks was taken and on five the placebo. The drink was prepared by mixing 32 g of Horlicks with 250 cc of hot milk. The drink or capsule was administered at 10-30 p.m. and the subject rose at 7-30 a.m. In this investigation, electrophysiological recordings which make possible discrimination between wakefulness and sleep were made.

The results indicated that all subjects slept for a minimum of seven hours on all nights. In the last hour of sleep nine of the young adults were found to have fewer movements after Horlicks. On an average, the older people slept less than the young. However, sleep after Horlicks was significantly longer and less broken in older people. The improvement was most apparent late in the night, and it increased with repeated administration of the drink.

Drs. Brezinova and Oswald conclude that their results vindicate the popular belief that "food is without any doubt the oldest and most widely used tranquiliser". A psychological explanation for their results appears very dim, due to the striking effects of Horlicks late in the night. They plead for more research to understand how Horlicks can alter sleep as much as seven hours after ingestion.

A number of criticisms of the above results have appeared in the later issues of the same journal in the form of letters to the Editor. The main objections are: (1) the control drinks were different from Horlicks in flavour and colour and (2) both hot milk alone or Horlicks made with hot water should have been tested as control. Only on the basis of such investigations can one feel justified in advocating the truly beneficial qualities of Horlicks. Further, tryptophan which is abundant in milk protein is a sleep inducer and the effect of this has not been eliminated in the above studies.

K. A. Neelakantan

blurs & bright spots

Statistician Extraordinary

TAGORE had called him his walking stick. A coveted compliment for any private secretary. He was also one of the most leaned-on men in the country. Because his head was full of figures and his trade had been to make figures speak.

Statistician extraordinary. Yet Prasantha Chandra Mahalanobis has stumbled on statistics by chance, during his last days at Cambridge where he had taken his Tripos in mathematics and physics. When he came back to India, he had brought some copies of Karl Pearson's *Biometrica* in his portfolio and a bug in his brain. The bug kept on biting, all through his tenure as the head of physics at Presidency College, Calcutta (he had graduated from there), as Tagore's Secretary and some years of close-linked association with Viswa-bharati. In 1931 he founded the Indian Statistical Institute at Barahnagar, a few miles from Calcutta. Two years later, he started *Sankhya*, the Indian Statistical Journal.

The statistical bug produced extraordinary results. Think of a country of hundreds of millions of people. Millions of acres of land, hundreds of inches of rainfall, rivers, deserts, green paddy-fields. Plan. Coordinate. Arrive at a meaning from the profusion of figures. Ask the statistician. Ask P. C. Mahalanobis. And ask him they did. Mahalanobis had started his work early, as early as 1925 when he studied the rainfall in North Bengal and Orissa, computed the figures, and the alternatives, and came out with a drainage scheme to cut down flooding.

You have two groups of people with more than one correlated factor. How do you compare them, classify them? Measure the generalised distance between them — apply Mahalanobis's D^2 statistics. Or you have a country faced with the enormous problem of developing itself. How do you go about making a plan? Especially if the economy is agriculture-based? Mahalanobis had started with the same questions. He had found most of the existing data faulty and tried to eliminate the errors by a crude graduation. It was then he came across the famous statistician Ronald Fischer's work. Fischer was the first to stress the importance of planning agricultural designs as an economic question which needs delicate balancing of cost with precision and availability of estimates. Fischer sent his papers to Mahalanobis.

Fischer's concept had a few difficult road-blocks. Mahalanobis came up with his own solution; he invented the Fractile Graphic Analysis (FGA). He used it to interpret the data collected in the course of National Sample Surveys. The FGA also resolves the difficulties encountered in comparing two groups of people of different socio-economic conditions. Each group is subdivided into equivalent fractile groups and then compared.

1949. Appointment as the Statistical Adviser to the Government of India. He was already working on his planning models (today you can find them in any text-book on planning) and these formed the rationale for the Second Five Year Plan, which became the prototype for all the subsequent ones. Planning Commission. Universities. Laboratories. Travelling, lecturing, being honoured. Fellow of the Royal Society of London, the American Statistical Association, the USSR Academy of Sciences. Chairman, UN Statistical Commission. A man of letters. A man of figures. Why did the Second Plan fail to live up to the projected figures? they had asked. " Maybe because I relied on computers", he had joked.

28 June, 1972. He would have been 79 the following day. The flowers they had ordered for his birthday now went with his bier.

Summer madness ?

IMAGINE that ! If you were born in the summer, you are likely to be mad. Doesn't sound quite right ? Try again : if you are mad, you were born in the summer. Don't get it ? Then ask Thomas F. McNeil and *Psychology Today.*

This is what the latter reports : " Summer-time maybe a risky time to be begotten. It

(Contd. on p. 41)

An educational and philosophic error?

RENÉ THOM

IN the minds of most of our contemporaries, the so-called modern mathematics holds a place of high prestige lying somewhere between cybernetics and information theory in the bag of tricks promoted by deceptive publicity as the essentials of modern technology, the indispensable tools for the future development of all scientific knowledge. And, on another level, since the modernisation of school curricula, many parents, no longer capable of helping their offspring, have become concerned. They no longer hear the old familiar notions in the vocabulary of their children, and thus feel lost when confronted with the new terminology. Some, perplexed, see this as one more symptom of the generation gap and have adopted an obstructionist stance towards the new ideas. Others, on the contrary, particularly those in the teaching profession, have accepted the new curriculum, ideas, and symbols with enthusiasm. What should we make of all this?

CURRICULUM REVISIONS. Let us list briefly the changes made in the curriculum:

1. *Added material:* (*a*) "Elementary" set theory, the use of symbols, ($\in$, $\subset$, $\cup$, $\cap$), the mappings of one set into another, and quantifiers. Most striking of all, sets now appear ubiquitously in the curriculum from kindergarten through the final year of secondary education. We will return to this point later. (*b*) Development of algebraic notions; laws of composition on a set; concepts of group, ring, and field. (*c*) Introduction earlier of fundamentals of differential and integral calculus, derivatives, indefinite integrals, elementary functions such as logarithm and exponential.

2. *Eliminated material:* Traditional Euclidean geometry, in particular the intricacies of plane geometry.

In sum, the reader will note that the curriculum has been modified by a substantial addition of material introduced in the secondary school years. The tendency to emphasise algebra at the expense of geometry is even greater in university teaching (see box on p. 27).

The elimination of traditional Euclidean geometry is based on two arguments. The first is theoretical: the axiomatic work resulting from Hilbert's *Grundlagen der Geometrie* has shown that the alleged rigour of the *Elements* of Euclid is in large part illusory; it is compromised by frequent appeals to intuition. As a consequence, the argument runs, it is better to avoid Euclidean geometry by developing the ideas of algebra, in which a rigorous presentation is possible. The second argument is a practical one: classical plane geometry, with its elaborate study of the triangle's properties, is useless and pedantic. Who in his lifetime ever needs to use the "Simpson's line" or the "nine-point circle"?

Let us first discuss the argument about utility. It is said that algebra is more useful and necessary than geometry. There is no question of denying the general scientific utility of linear algebra or of certain notions of multilinear algebra. As for general commutative algebra — polynomials, etc — caution is in order. In ordinary life, who has ever needed to solve a second-degree equation or to use explicitly the notion of a module over a ring? The argument for the utility of algebra is not as compelling as it appears. As for differential and integral

calculus they are indispensable for any presentation of classical physics.

At an elementary level, certainly, the use of algebra leads to massive simplifications. Solving " through reasoning " the " word " problems one used to have as a 12-year-old required an extraordinary dexterity of mind, whereas the algebraic solution was purely mechanical. Here the economy of thought introduced by algebra is undeniable. With more complex situations, however, the advantage of algebra tends to disappear. Descartes devised analytic geometry in order to reduce geometry to algebra, but it is a fact well known to all university applicants who have crammed for advanced standing in mathematics that the advantage of analytic methods over geometric ones for a qualitative theoretical problem is far from being decisive.

MODERNISM. For professional mathematicians, the use of algebra as an instrument of proof is highly important and perhaps essential. Contemporary mathematicians, steeped in the ideas of Bourbaki, have had the natural tendency to introduce into secondary and university courses the algebraic theories and structures that have been so useful in their own work and that are uppermost in the mathematical thought of today. Yet one can ask with reason if the needs of specialists and their latest findings should be introduced into the school curriculum. Mathematicians are not alone in succumbing to this temptation. I have read biology texts — both for beginners and advanced students — in which the DNA double helix of Watson and Crick and the precise enzymatic mechanism of its replication are presented as definitely scientific truth. Innovations should not be introduced into the curriculum without a certain waiting period.

The problem of geometry: In the last analysis, the argument about the utility of material presented in the curriculum is perhaps not the decisive one. Let us ignore " culture — that which remains when all else is forgotten ", as a vestige of times past. Some still persist in thinking that, in one form or another, one of the goals of teaching is selection, that is to say, determining the aptitudes of each student and developing them to the maximum, with particular emphasis on the gifted student. I claim that it is impossible to carry out such a task in the framework of a discipline that does not include at least some gratuitous, nonuseful aspects. In order to judge fully the capabilities of a student, it is necessary to place him in an active role and to call on his individual initiative and enterprising spirit. None of this is conceivable within a framework of " useful " studies, where all the elements, included because of their technical utility, are dogmatically taught and where scholarly excellence is defined as exact and rapid memorisation of given material. Only those topics which have a quality of " play " have educational value, and of all such games, Euclidean geometry, with its constant references to underlying intuitively understood fundamentals, is the least gratuitous and the richest in meaning.

By this line of reasoning, the contemporary trend to replace geometry with algebra is educationally baneful and should be reversed. There is a simple reason for this: while there are geometry problems, there are no algebra problems. A so-called algebra problem can only be a simple exercise requiring the blind application of arithmetical rules and of a pre-established procedure. With rare exceptions, one cannot ask a student to prove an algebra theorem; either the requested answer is almost obvious and can be arrived at by direct substitution of definitions, or the problem falls into the category of theoretical algebra and its solution exceeds the capacities of even the most gifted student. Exaggerating only slightly, one can say that any question in algebra is either trivial or impossible to solve. By contrast, the classic problems of geometry present a wide range of challenges.

Geometry problems require a combination of time, effort, concentration, and powers of association of which few students are capable. Perhaps Euclidean geometry, like Latin translation, is one of those lofty, obsolete exercises that are limited to the elite and incompatible with mass education. If such is the case, expelling geometry from the curriculum becomes essentially a sociological question that I do not wish to discuss here. Still, it would be a grave error to hope to simplify the learning of mathematics by replacing geometry with algebraic structures that are then widely and prematurely taught without adequate motivation.

RIGOUR. Let us now turn to the objection to Euclidean geometry that criticises the axiomatics of the *Elements* as being flawed and lacking in rigour. One can point out, first of all, that geometry books long ago gave up the heavy, indigestible rhetoric of Euclid. Some cherished the hope of substituting an acceptable version of Hilbert's *Grundlagen.* Not surprisingly, this hope was defeated by the dreadful complexity of this work. One cannot take a stand on this issue without first attacking the philosophical

In India...

NEW mathematics was introduced in some of the Indian schools about two years ago. It started with a transitory syllabus. While retaining most of the old mathematics, the new syllabus included some new concepts. Compared to the radical changes in the European and American curricula, the changes in India are very elementary.

For instance, the new algebra syllabus teaches new symbols and notations and only elements of set theory, based mainly on examples from day-to-day life. More prominence is given to structural properties of familiar number systems such as natural numbers, integers, rationals and reals and their application in algebra. Earlier, order-relation was not studied. And neither were inequalities and inequations, which are now taught in schools. The rest of the syllabus has remained practically the same.

In geometry, a synthetic approach has been adopted. Euclidean geometry is still taught, but more systematically with emphasis on axioms and rigorous definitions. Thus the new mathematics is less dogmatic; what was taken to be absolutely true is now stated as axioms and rules. For example, congruency is no more proved but is decided on rules. Secondly, geometry is taught with real numbers.

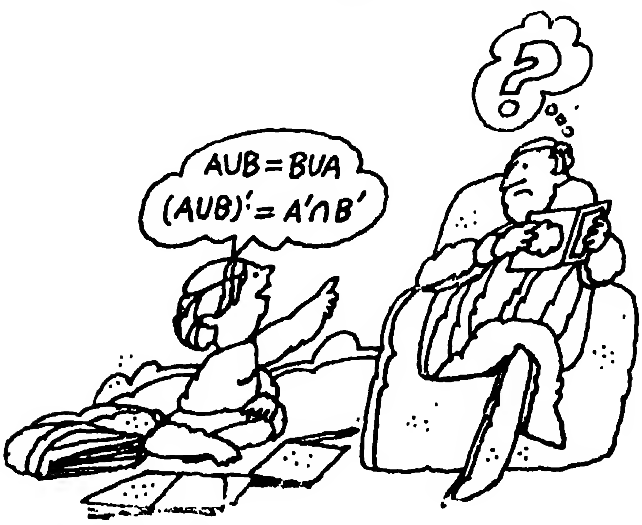
Of course, the new symbols and notations (given below) have caused some confusion, particularly for the parents. In scrapping Euclidean geometry altogether and shifting heavily to algebra and set theory, Western mathematicians sought to solve many of the mathematical problems rigorously. But experience has shown that modern algebra cannot solve all the problems; there are still many ambiguities. Besides, it has also created too much abstraction in high school mathematics. Meanwhile, the debate among Indian mathematicians still goes on. While one group wants modern algebra and set theory to be introduced in schools, the other wants a slow transition, with major changes to be introduced only at the college level, where a student begins to specialise. Maybe the European experience has some relevance here.

Some of the notations used in new mathematics are: ε is an element of, ϕ the empty set, $\cup$ the union of, $\cap$ the intersection of (and), $\subset$ is a subset of, is contained in, $\supset$ contains as a subset, A′ the complement of the set A, $=>$ implies that, $<=$ is implied by, $<=>$ is equivalent to.

The set theory classifies objects into well-defined groups. A *set* is thus a collection of well-defined objects, called *elements* or *members*, like the vowels of the English alphabet, or a set of odd numbers. The latter, however, is an *infinite set* as the number of elements here is infinite. The *null* or *empty set* is one in which there is not even one element, like $\{$ An Indian city with a tube railway $\}$. Further, every set belongs to a *universal set* (denoted by U). For example set $A = \{2, 4, 6\}$ belongs to a universal set of even numbers. Similarly $B = \{2, 6\}$ is a *subset* of set A, and is denoted as $B \subset A$. Two sets without any common element are known as *disjoint sets*; for example $\{$ men $\}$ and $\{$ women $\}$. Non-disjoint sets are called *overlapping sets*. These set concepts are expressed by *Venn diagrams*. A universal set, for instance, is represented by a rectangle, and a set by a closed curve. Overlapping sets have intersecting closed curves; disjoint sets have non-intersecting closed curves.

question of what conception of mathematical rigour one should adopt. Three attitudes are possible : (1) the formal view. In a formal system S, a proposition P is true if it can be deduced from the axioms of S by a finite number of steps permitted within the system of S. (2) the realist or Platonic view. Mathematical entities exist independently of thought, as Platonic ideas. A proposition P is true when it expresses a relationship actually existing between ideas, i e when it is an idea of a higher order, structuring a group of ideas that are subordinate to it. (3) the empirical or sociological view. A proof P is accepted as rigorous if it obtains the endorsement of the leading specialists of the time.

Of these three attitudes, mathematicians today favour the first. At first sight, it is the most tempting; it does not raise the ontological difficulties of the second, and it is not as vague and arbitrary as the third. Bertrand Russell has said that " mathematics is the subject in which we never know what we are talking about nor whether what we are saying is true ". Unfortunately, the purely formal view is difficult to uphold, paradoxically for formal reasons.



One more symptom of the generation gap . . . ?

We know the difficulties presented by the formalisation of arithmetic associated with Godel's Theorem. For myself, I am content with the following illustration: Let us suppose that we have been able to construct for a formal theory S an electronic machine M capable of carrying out at a terrifying speed all the elementary steps in S. We wish to verify the correctness of one formula F of the theory. After a process totalling 10^{30} elementary operations, completed in a few seconds, the machine M gives us a positive reply. Now what mathematician would accept without hesitation the validity of such a " proof", given the impossibility of verifying all its steps? "*Meaning*" *in mathematics:* Any mathematician endowed with a modicum of intellectual honesty will recognise that in each of his proofs he is capable of giving a meaning to the symbols he uses. Because of this, his work differs from that of the theoretical physicist, who very frequently does not hesitate to put his trust magically in the virtues of blind formalism in the hope (often deceived) that the light at the end of the tunnel will dispel the intervening darkness.

If one gives up the formal definition of rigour, one must of necessity choose between the two remaining alternatives. Everything considered, mathematicians should have the courage of their most profound convictions and thus affirm that mathematical forms indeed have an existence that is independent of the mind considering them. This existence is without doubt different from the concrete existence of the external world, but it is still subtly and deeply related to it. If mathematics is only an arbitrary game which is the random product of cerebral activity, how can one explain its unquestioned success in describing the universe? Mathematics is found not only in the mysterious fixed order of physical laws but also, in a more hidden, though equally certain manner, in the infinite succession of animate and inanimate forms and in the formation and breaking up of their symmetries. Despite appearance, this is why the hypothesis stating that Platonic ideas give shape to the universe is the most natural and, philosophically, the most economical.

Yet, at any given moment, mathematicians have only an incomplete and fragmentary vision of this world of ideas. As a result, each proof is, above all, the revelation of a new structure whose elements lie disconnected in man's intuition until reason joins them together. In this sense, each proof is a Socratic experience requiring the recreation in the reader of the psychological processes necessary to elicit the implicit truth, all the elements of which he possessed but which had remained hidden in an unformulated state. In this sense, there is no contradiction between the second and third views. The world of ideas is not revealed to us in one stroke; we must both permanently and unceasingly recreate it in our consciousness.

The opponents of the ontological view would do well to reflect on the following: There is no case in the history of mathematics where the mistake of one man has thrown the entire field on the wrong track. Frequently, mathematics has become lost in the formal development of insignificant, uninteresting theories. It has done so in the past, does so today, and will certainly continue to do so in the future. But never has a significant error slipped into a conclusion without almost immediately being discovered. How could one explain such a consensus if it did not correspond to a general opinion that is the result of the mind's struggle with permanent, timeless and universal constraints? With this confidence in the existence of an idea universe, the mathematician need not worry unduly about the limits of formal procedure; likewise, he can forget the problem of noncontradiction, for the reason that the world of ideas infinitely exceeds our " technical possibilities". It is in the intuition that the *ultima ratio* of our faith in the truth of a theorem resides. And, according to a now-forgotten etymology, a theorem is above all the object of a vision.

EACH MUST DECIDE FOR HIMSELF. There is no rigorous definition of rigour. We

will therefore affirm that any proof is rigorous if it wins acceptance by all readers who are adequately educated and prepared to understand it. Furthermore, the evidence leading to persuasion results from having a sufficiently clear understanding of each of the symbols involved, so that their combination convinces the reader. From this point of view, rigour (or its contrary, imprecision) is essentially a *local* property of mathematical reasoning. No elaborate axiomatic structure or refined conceptual machine is needed to judge the validity of a line of reasoning. It suffices merely to have an understanding of the meaning of each symbol involved and a clear idea of how to combine them.

Limits and necessity of axiomatisation. Such a point of view suggests that we retreat somewhat from axiomatics. To formalise a theory means, starting with the material presented by the theory which is organised as an intuitive "morphology" T, to give a formal set of symbols and rules generating a formal system S isomorphic to the morphology T; the isomorphism $S \rightarrow T$ being precisely the correspondence which attaches to any symbol s belonging to S its "meaning", i e its intuitive content in T (its semantic realisation, logicians would say). Can one reasonably hope that the intuitive material of the theory T can be fully covered by the symbolic expressions of S? An example immediatly comes to mind, that of natural languages. Linguists of the formalist school have been trying strenuously to reduce natural language grammar and syntax to axioms. In doing so they have come up with a certain number of formal procedures — generative and transformational grammars — whose validity, on the level of formal description of the sentences contained in the corpus, cannot be denied. But if these procedures are systematised into a series of rules which are then pursued blindly to their logical conclusion, the resulting sentences soon become so long and complex that they lose all meaning.

. . . some, particularly teachers, have taken to new maths with enthusiasm

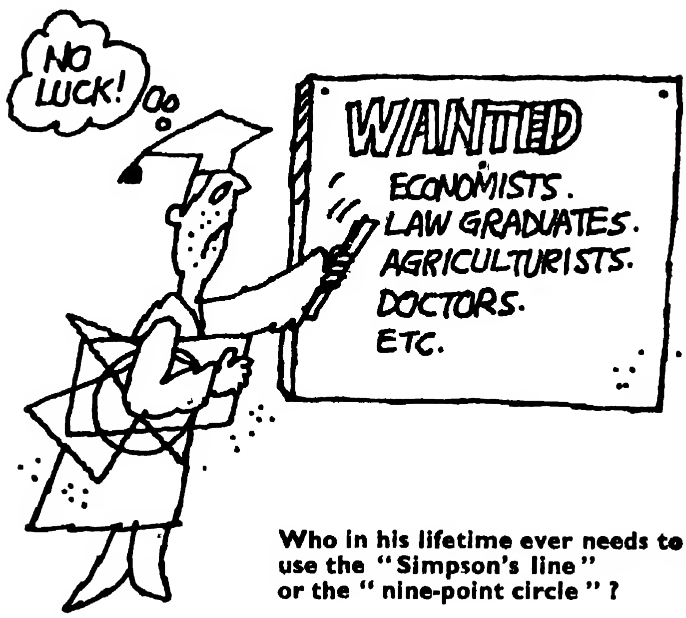
I see no reason why a similar phenomenon could not happen in mathematics; in extrapolating a formal mechanism to the limit of its generative capacities, it does not take long to assemble formulas that are so long and complex that all possibility of intuitive interpretation disappears. The "theorems" thus obtained will probably be formally correct but semantically insignificant. Thus for a given intuitive theory T, one must expect to have to use not one but several "local" axiomatisations; each local axiomatisation S has a contact zone Z_s in the morphology for which S is valid; but as soon as one constructs formulas in S which are too long or involved, the intelligibility disappears. At the boundary of the zone Z_s the semantic link between S and Z_s breaks down; this prohibits the extension beyond Z_s of the isomorphism $S \rightarrow T$, defined by the meaning. The idea that a theory T could be generated by just one formal system S is, a priori, just as unlikely as the idea that the Earth should be flat or that one could cover a surface by a single system of coordinates. It would be interesting to understand this semantic breakdown more clearly. Below, we shall see a striking example of what happens when the rules of combination are incompatible with the semantic qualities of the symbolised entities (in this case, Boolean formalism applied to ordinary language). In the case of mathematics, it appears that such a semantic breakdown occurs in a progressive, hazy manner (the case of "transfinite numbers" in set theory, for example).

The undeniable advantage of local formalisation is frequently to make intuitively understood ideas more precise and, most indispensably, to permit communication between mathematicians. As all means of communications, spoken or written, use a one-dimensional morphology, it is necessary to code the intuitive morphology T (which in general is defined on a multidimensional space) into a formal system of one-dimensional symbols. During the past few years the importance of axiomatisation and discovery has been much emphasised. As a method of systematising, it is certainly effective; as for discovery, the matter is more doubtful. It is characteristic that no new theorem of any importance came out of the immense effort

at systematisation of Nicolas Bourbaki (which in itself is not a true formalisation because Bourbaki uses a nonformalised metalanguage). If mathematicians refer to Bourbaki, they usually find more food for thought in his exercises — to which the author relegated the concrete material — than in the deductive part of the text. One must say it clearly : axiomatisation is the work of specialists and has no place in secondary or college teaching except for those professionals specialising in the study of foundations. All this explains why the reproaches of inconsistency directed at Euclidean geometry are irrelevant; they do not touch the validity of local intuitive reasoning.

"GENETIC" IMPORTANCE OF GEOMETRY. Continuity precedes discontinuity. The foregoing considerations reveal the key to the historical success of Euclid's *Elements*. Euclidean geometry is the first example of the transcription of a two- or three-dimensional spatial procedure into the one-dimensional language of writing. In this, Euclidean geometry applies to a rigid, precise situation, a procedure which is already present in everyday language. The primary function of ordinary language is, after all, to describe the spatiotemporal processes which surround us, and whose topology is transparent in the syntax of the sentences describing them. In Euclidean geometry we are dealing with the same function of language, but this time the group of equivalences operating on the forms is a Lie group, the metric group, in contrast to the groups describing the more topological invariance of the "gestalten" that permit us to recognise objects of the exterior world as described by their natural language names.

As such, geometry is a natural and possibly irreplaceable intermediary between ordinary language and mathematical formalism, where each object is reduced to a symbol and the group of equivalences is reduced to the identity of the written symbol with itself. From this point of view the stage of geometric thought may be a stage that is impossible to omit in the normal development of man's rational activity. Much emphasis has been placed during the past 50 years on the reconstruction of the geometric continuum from the natural integers, using the theory of Dedekind cuts or the completion of the field of rational numbers. Under the influence of axiomatic and bookish traditions, man perceived in discontinuity the first mathematical Being : "God created the integers and



Who in his lifetime ever needs to use the "Simpson's line" or the "nine-point circle"?

the rest is the work of man." This maxim spoken by the algebraist Kronecker reveals more about his past as a banker who grew rich through monetary speculation than about his philosophical insight. There is hardly any doubt that, from a psychological and, for the writer, ontological point of view, the geometric continuum is the primordial entity. If one has any consciousness at all, it is consciousness of time and space; geometric continuity is in some way inseparably bound to conscious thought.

Gradually, however, this initially homogeneous, amorphous continuum takes on a structure, and the most important structuring tool is the metric group. It alone permits us to introduce discontinuity and discrete operations into the homogeneous expanse. This is, however, a very sophisticated procedure. To begin with, we had all the topological properties of the continuum, but only in modern times has mathematics returned to its sources in founding topology, thus freeing itself from the domination of the metric group. Such a theory, being neither metric nor quantitative, is basically qualitative and can rely only on the discrete symbolism of a semiformalised language. However, topological invariants, being more deeply rooted, are more difficult for the mind to conceive than the more superficial metric invariants. With this point in mind, we can see that the transition from everyday thought to formalised thought takes place naturally through geometric thinking. This has always been the case in the history of human thought

and, insofar as one believes Haeckel's Law of recapitulation, which states that in his development the individual passes through all the stages of the species, it should be the case in the normal development of rational thought.

I come now to my first point, set theory. This is the essential litany intoned by those who advocate the so-called modern mathematics. Some affirm that the use of set theory permits the entire renovation of mathematics teaching and that, thanks to this change, the average student will be able to achieve mastery of the curriculum. Needless to say, this is pure illusion. As long as it is a matter of handling the obvious facts of naive set theory, of course anyone can get by. But this is neither mathematics nor even logic. As soon as one comes face to face with real mathematics (ie real numbers, geometry, functions), one rediscovers that there is no royal road and that only a minority of students are capable of fully understanding the material.

Everything considered, the excessive optimism bred by the use of set theory symbols has its roots in a philosophical error. It was believed that by teaching the use of the symbols ε, $\subset$, $\cup$, $\cap$, it was possible to make explicit the mechanisms underlying all reasoning and deduction. Twentieth-century man has enthusiastically rediscovered the syllogisms Darapti and Celarent taught by the medieval scholastics. But what a deterioration has taken place! When, in the nineteenth century, Boole wrote the celebrated treatise on algebra that bears his name, he did not hesitate to entitle it " An Investigation into the Laws of Thought ". The naive belief that every deduction finds its model in set theoretic manipulations was shared by such modern philosophers as the neo-positivists. Neither Aristotle nor the medieval scholastics shared this illusion. As J. Vuillemin reminds us, Aristotelian logic has its base in a rich and complex ontology of substance. Modern protagonists of set theory should realise that this theory is insufficient to account for even the most elementary deductive steps of ordinary thought. Permit me to give an example of this fact.

THE COPULAS OR AND AND. Classically, it is taught that the grammatical equivalent of the symbol $\cap$ (union) is *or* and that of the symbol $\cup$ (intersection) is *and*. Let us apply this rule to two simple sentences whose subjects are proper names:

(1) Peter or John is coming.
(2) Peter and John are coming.

The first sentence can be paraphrased, " Peter is coming or John is coming ". Here there is complete agreement of the symbol *or* with the logical union $\cup$, with the condition that the copula refers not to the subject but to the verb " to come ".

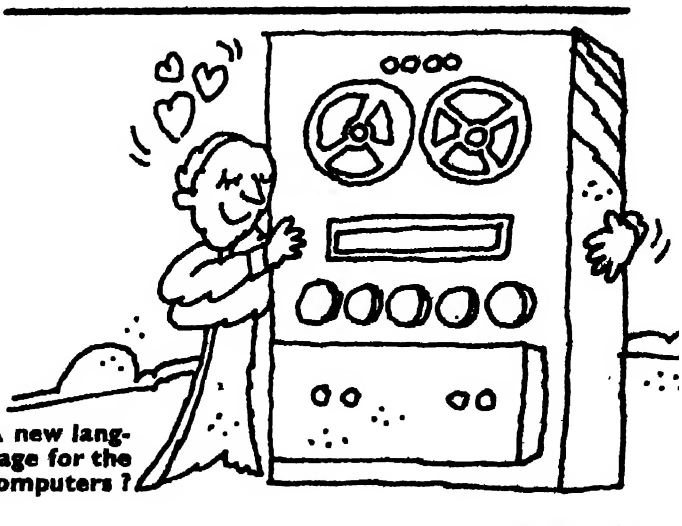
The second sentence too can be paraphrased, " Peter is coming and John is coming ". Having done this, one realises that the original sentence is subtly ambiguous, for it implicitly contains what linguists term " presuppositions ". For example, " Peter and John are coming " frequently presupposes, " Peter and John are coming *together* ". While the phrase " Peter or John " alone has no semantic interpretation, it is possible to conceive of " Peter and John " as an entity formed by a pair of individuals, Peter and John, who, spatially, are together. This fact explains the different grammatical treatment of the verbs in (1) and (2) : the copula *and* requires the plural because it presupposes a certain spatial contiguity of the subjects.

Let us consider some sentences in which copulas are used with qualities:

(3) Peter is short or intelligent.
(4) Peter is short and intelligent.
(5) Joan's hair is gray or brown.
(6) Joan's hair is gray and brown.

Sentences (4) and (5) are semantically acceptable whereas (3) and (6) may be dubious or unacceptable. One may extrapolate these remarks to the following principle: Exclusion principle : If X and Y are two qualities, the sentences A is X or Y, A is X and Y cannot both be semantically acceptable.

When " X or Y " may be preceded by a subject, one would say that X and Y belong



A new language for the computers ?

SKETCHES BY SABIR

to the same semantic field: for example, "gray" and "brown" in sentences (5) and (6). In this case, "X and Y" is, in principle, meaningless. There is, nevertheless, an important exception, the case where *and* designates not logical intersection but spatial contiguity. Thus it is perfectly possible to say: (7) This flag is white or blue. (8) This flag is white and blue. The fact that in (8) the copula does not have the meaning $\cap$ explains why "This flag is white and blue" implies that "This flag is white" is false.

Indeed, the conditions necessary for the expression "X or Y" to be meaningful are extremely restricted; thus "Joan has red or auburn hair" is clearly more acceptable than "Joan has red or brown hair" because, in terms of the semantic category of hair colours, "red" and "auburn" are adjacent to one another whereas "red" and "brown" are not. The copula *or*, geometrically speaking, has the effect of lowering the threshold between the domains of attraction defined by the adjectives "red" and "auburn". When the semantic distance between two qualities X and Y is too large, in particular when these qualities belong to different semantic fields, as with a physical quality and a moral quality, then the phrase "X or Y" loses all meaning.

Although it is rather obvious, this fact seems to have escaped the authors of many set theory textbooks. They offer students exercises in Boolean algebra which discuss "cubes that are big or blue", and "Parisians who are bald or rich". Not only are these exercises outlandish and useless, but, if pursued too far, they can become harmful to the child's intellectual equilibrium. One of the fundamental constraints imposed by accurate thought is precisely the avoidance of mixing distinct semantic fields. This mixing has a name — delirium. In attempting to attach meaning to all the phrases constructed in ordinary language according to Boolean rules, the logician proceeds to a phantasmic, delirious reconstruction of the universe.

All these points show the narrow limits of set theory in describing ordinary thought. Everyday reasoning calls upon profound psychic mechanisms, such as analogy, which can never be reduced to the level of set theoretic operations. An important factor in such cases is the organisational isomorphism between semantic fields which are homologically associated.

In fact, Boolean schematisations hardly apply without some defect except in cases described by spatial inclusions of subsets in space, as in Venn diagrams. In such a case, no one will take the trouble to put the reasoning in a syllogistic form. The fox knows that if the hens are in the hen-house and the hen-house is in the yard, then the hens are in the yard; he does not bother with set theory. Everyone uses set theory from the moment he exists, just as M. Jourdain in Moliere's *Le Bourgeois Gentilhomme* uses prose without knowing it. Some say that it is better to use it knowingly. The advantage here, if there be any at all, applies to the rhetoric. It is only to the extent that the technique of mathematical proof is a type of rhetoric that it becomes worthwhile to proceed by local formalisations — which actually are local "spatialisations" — and to apply the set-theoretic formalism to them. The persuasive force of the logical scheme comes from spatial inclusions, and not vice versa. This indicates to us the attitude that reasonable educational thought should take towards set theory. In its simple, concrete form, it should be introduced in kindergarten, which is its natural habitat. In the early years of secondary school, students should learn the use of the symbols ε, $\cap$, $\cup$, $\subset$, later they should be introduced to the quantifiers, and that should be the end of it.

It is not certain that, even in pure mathematics, each deduction can have a set-theoretic model. Poorly resolved paradoxes that undermine formal set theory are there to remind the mathematician of the dangers that await him in the injudicious use of these seemingly innocent symbols. Perhaps, even in mathematics, quality subsists, and resists all reduction to sets. The old hope of Bourbaki, to see mathematical structures arise naturally from a hierarchy of sets, from their subsets, and from their combination, is, doubtless, only an illusion. No one can reasonably escape the impression that the most important mathematical structures (algebraic structures, topological structures) appear as fundamental data imposed by the exterior world, and that their irrational diversity finds its only justification in reality.

RENÉ THOM is recognised as France's leading geometer His works on the topology of differentiable manifolds won him the Fields Medal at the International Congress of Mathematicians in 1958. **This paper, the translation of an article from *L'Age de la science 3*: No. 3, 225-36, appeared in *American Scientist*, Vol. 59, No. 6.**

brain teasers

BETWEEN YOU AND ME (OR THE LAW OF AVERAGES)

IN this world of everchanging values and concepts, the precise and exact science of mathematics is a very great relief. While broad ties and maxi-skirts may be " out " tomorrow, at least one and two will still be three!

Or will they?

Ask any chemist . . . and he'll tell you that two litres of hydrogen added to one litre of oxygen will only give you one litre of water vapour!

But ignoring the intricacies of such "dubious" interpretations, there is still a whole vast panorama of mathematics that is generally misleading because of distortions in popular usage. It is to give you a clearer concept that these brain teasers are posed. Some of these are found in varied forms in many books of puzzles and mathematical recreations, but these have been systematically presented here to illustrate the most popular misconceptions and fallacies of mathematical fundamentals. The posers are so presented as to make entertaining diversions at any gathering — be it a long train journey, or a pause between two dances at a party. And they " enlighten " . . . a " learn while you play series " highlighting certain popular fundamental misconceptions. Each series covers one aspect of mathematics and the answers to all the " posers " are grouped at the end. You are advised to try them out for yourself and to record your answers before waiting for the given solutions to test your own fundamentals first.

Take a try.

If I have Rs. 10 and you have Rs. 20, we all know that between us we'll have an average of Rs. 15 per head. Now figure out the following:

(1) Ashok was driving from A to B — a total distance of 200 kilometres. He drove the first 100 kilometres at an average speed of 50 kilometres per hour.

At what average speed must he drive the remaining 100 kilometres to average a speed of 100 kph between A and B?

(2) Two workmen were employed by a Bunia — and each worked 10 hours a day, six days a week.

The first employee was paid a rupee for every two hours of work, or Rs. 30 for 60 hours of work every week. The second employee, a beginner, was paid a rupee for three hours of work, or Rs. 20 for 60 hours of work every week. Between the two, they got Rs. 50 for 120 hours.

However, hearing of " unions " and " equal rights ", the workmen decided to go to the Bunia and ask him for consolidated wages. They figured that as one was getting a rupee for two hours work, the second a rupee for three hours work, they should be paid at the average rate of Rs. 2 for every five hours of work (i e Re. 0·40 per hour).

The Bunia readily agreed.

At the end of the week, he calculated a total of 120 hours — and paid them Rs. 48 (120 × Re. 0·40) The workmen found that they couldn't argue, but between them they had lost Rs. 2.

Where did they go wrong?

(3) The tortoise and the hare decided to race. The tortoise started from A for B and the hare from B for A; the distance between the two being three kilometres. The tortoise moved steadily forward at an average rate of 200 metres per hour. The hare, who could race at an average of 10 kph started after an half hour nap! Which of the two was closer to B when they crossed each other?

Sam Dalal

Solutions to last month's Brain Teasers

The first two problems were contributed by G. A. D. Prasad. In " The bus trip ", 93 passengers travelled by the bus on that experimental trip. In " A clockwork problem", the time was 18 hours, 51 minutes, 30 seconds on Thursday — after four days. The time shown by the wall clock and the time piece was therefore 3 hours, 25 minutes, 47·5 seconds. In " The multiplying flowers", each deity got four flowers. The sadhu picked three flowers from the garden.

In " Fortune Hunting ", Brain Teasers, March 1972, the last sentence should read " Now, if the father took an identical amount from each son, how much of his Rs. 20,000 did the father give his first son?" The answer is then Rs. 17,000. As stated, the problem has four answers: Rs. 3,000, Rs. 6,000, Rs. 9,000 and Rs. 12,000.

HOUSE collapses are not confined to Bombay. They can occur anywhere, though in Bombay, with its over-crowding and clusters of rickety houses, the monsoon routinely takes its annual toll of death. Over a thousand houses collapsed during the last decade, claiming a toll of over 168 lives.

Most of these houses are timber-frame buildings with masonry walls. Concrete structures are relatively new in India, and if there is a collapse, it is during the constructional stage, normally because of accidents or negligence. A survey showed that 33 per cent of Bombay's 36,000 residential buildings are timber-framed, and 42 per cent are of masonry walls. Only about 9 per cent of the buildings are of modern construction — steel, concrete and masonry.

Timber-frame structures are normally constructed with teak wood flooring, timber floor beams (joists) and teak wood posts (see sketch) transferring the load to the post or the load-bearing wall. In turn, the load at every floor is transferred to similar systems below and through them to the ground floor and then to the foundation.

Normally such structures last 60 to 70 years, if they are properly maintained. But often due to negligence and ill-maintenance, the life is shortened. Nobody takes much care of the deep cracks, the peeling plaster or the decaying beams and posts. Of course, the main supporting systems such as the walls, the horizontal beams or joists and the columns try to bear the load as far as possible. When they fail, the building collapses.

WHAT causes decay in such buildings? Aging is the main reason. But there are several other factors, like the direct exposure of the bricks and mortar and the timber structural members to alternate conditions of sun and heavy rain. Water from leaking roofs, toilet and bathrooms seep through the walls which leads to warping, wet rots and fungus, finally reducing the effective dimensions of the structural members. Engineers say that 90 per cent of the house collapses follow the deterioration of the toilet and bathroom sections.

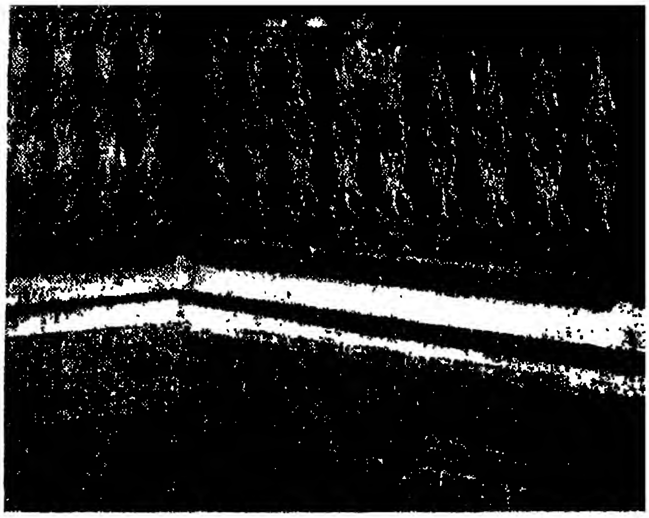
HOUSE COLLAPSES

WHEN the structural members decay, they set off a chain reaction. For instance, if the horizontal joists are damaged, their length is reduced at the end sections where they rest on the walls. The joist is now no more able to support the load it was designed to carry. The load is transferred to the adjoining joists and to the walls or beams. Overstressing results, and soon cracks begin to appear along the walls. Generally these are observed above the arch-type openings in the walls. At times, they extend below the openings.

Or if the filled-up material between the beams is not firm, the fillings become loose in the process of transferring the load. Cracks develop, letting water seep through them. Such cracks can also be caused by the unevenness of the floor following the decay of the vertical supporting posts. In all such cases, the load is transferred to the walls and the supporting timber frames.

Often rain water pipes, drainage and sanitary fittings are either cracked or chocked. Leakage of water from the roof damages the beams supporting the roof. They begin to sag and exert a sideward thrust on the walls, leading to bulging, cracking and sinking of certain portions, particularly verandahs and balconies. The balconies then sag along the front end, depending on the method of construction. This sinking causes a reaction at the other end of the structure. It deflects the base of the balcony and strains the walls and the wooden framework.

Common passages, verandahs, staircases, etc are usually exposed to direct atmospheric

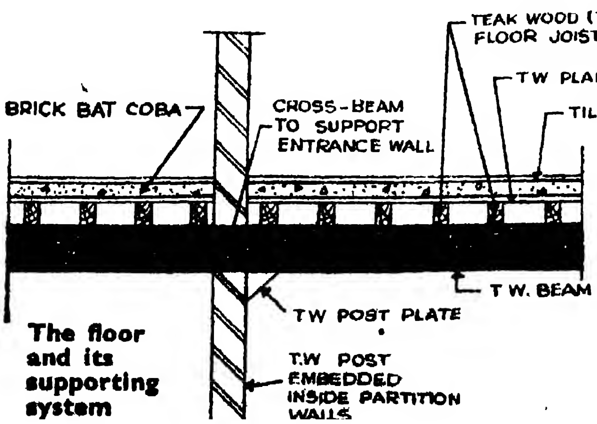


External passages have settled owing to leaky roofs, damaged rain-water connections, ill-maintenance, direct exposure to sun, wind and rain. The settlement between the main beams of the passage is clearly seen in the corner. Steel straps have been provided to hold them in position. The passage railings have also sunk

effects. They then undergo changes in their structural properties like a change in effective cross-sections and a decrease in elasticity. The result is deflection, and eventually the floor and the adjoining supporting systems sink or crack. A decaying staircase upsets the level of the flooring landing beam.

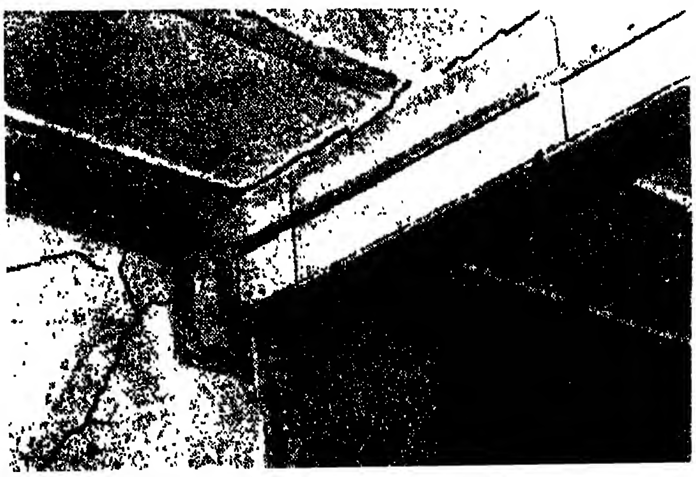
THOSE deep cracks you notice on the walls may look harmless. But they are actually the symptoms of some deep-rooted trouble. Yet no notice is taken till the trouble goes beyond repairs. Cracks are caused by over-stressing, uneven distribution of load and sometimes by "sympathetic cracking"

Right: Rear wall of a building which is proposed to be demolished and reconstructed. The drainage pipe is broken; leakage has damaged the wall. Cracks run from the window top to the sill. The arch-type brick lintels are severely cracked at all openings. Drainage and sanitary connections are bad



The floor and its supporting system

↑ **Chunks of brickwork have fallen off, the window sill is cracked, the teak wood post is off-centre and a rubber tube has replaced the drainage pipe. How did this occur? The floor joists (beams) on the upper floors had decayed. They exerted a lateral thrust on the walls; the lintel above the window failed. The foundation too had settled following rodents burrowing into it and leaking drainage connections. And when the foundation settled, the wall bulged out**



following the release of energy. When the brick and mortar are exposed to alternate drying (sun) and wetting (rains and leakage), they expand and contract to different degrees because of different thermal coefficients. This too leads to cracks. And so do the difference in chemical properties between the brick and the lime and the difference in aging between the timber and the brickwork (timber loses almost 50 per cent of its load-carrying capacity by about 60 years while the brickwork remains relatively fresh).

Decayed beams and posts are often hidden by plasters. And not even the routine inspections spot them. Depending on the location and the timber used, teak wood posts decay where they are embedded deep in the floor; the beams decay over the junctions. When this decay is severe it reduces the effective area available for load transfer. And when the column junctions sink, the beams resting on them too sink, upsetting the flooring and causing difficulties in closing the doors. Often the door frame cracks at the bottom.

Finally it is the foundation which takes on the weight of the building. If the foundation is weak, over the years it tries to settle. No harm is done when it settles evenly, maybe the structure will sink by a few centimetres. But when it settles unevenly because of the damage done through water seepage or cavities formed by rodents or any other reason, the balance shifts and the structure may tilt. If such settlement is severe, the building may even collapse. In fact, foundation failures have caused quite a few disasters.

There is another important factor — propping. Any work which needs structural repairs, replacement, strengthening, alterations of structural members needs propping. Correctly done, propping can save repairing costs. Otherwise it can lead to collapses. A striking example is the lodging house collapse in Bombay which killed 23 persons last year. And the number of such accidents is increasing.

Propping basically transfers the load of the existing system to a temporary system. This

←

Cracks and black spots. The steel beam settled as the supporting beam seat failed. The resultant pressure cracked the wall (lime mortar brickwork). Also note the cracked portion of the lintel over the window. This is due to the corrosion of the steel beam inside. A long crack runs on the other side of the lintel. The black spots on the flooring steel joists are corrosion marks

is done by raising the existing load system by a fraction of an inch, so that the load is transferred. But generally not much care is given to this important function ; at times, this is even left to semi-skilled or unskilled carpenters. Often it is shorter in length than the original support heights. Propping should normally transfer the load to the ground floor. It should also consider the load on the props, its location, lateral stability and its position taking into account construction difficulties. But often propping is done haphazardly. And wrong propping can lead to cracks in the flooring and the partition walls.

Proper maintenance (see box) like regular white-washing, painting, etc to protect the walls and timely repairs can prolong the life of a building. But often the question is who is to pay — the tenant or the landlord? In Bombay, the State government has set up a Housing Repairs Board which looks after these repairs. All a tenant has to do is inform the board. Cities like Delhi and Calcutta are also thinking of setting up such boards.

[The report is based mainly on a forthcoming book "Technology of Building Repairs" by R. N. RAIKAR, a consulting structural engineer, Bombay.]

Maintenance . . .

A little maintenance will go a long way in prolonging the life of a building. What are these maintenance measures ? Here are some.

Nahanis: **Clean them frequently, forcing two or three buckets of hot water down the nahani trap. This will loosen up the oils, fats and dirt particles clogging the trap.**

Roofs: Cover leaky spots with tar cloth. Get the decayed roof members repaired before the monsoon. Chocked up rain water pipes should be cleared and repaired.

Drainage connections: Overflowing drains, leaking nahanis, floor, toilet and bath sections should be attended to. Do not let water trickle along the walls since it can lead to further damage.

Walls: White-wash the external walls regularly. Preferably use a cement-based paint to protect the walls from rain damage.

Timber members: Coat them with oil paint at least once every ten years.

Cracks: Cracks in the walls should be cemented. Such cracks can be filled with reinforced cement bands. Cracks let moisture and other natural decaying agencies into the walls.

Left : Portion of an airconditioned office. Steel joists are used for the flooring, and steel beams encased in concrete for lintels. The brickwork is in lime mortar. Following leakage, the plaster became loose and cracked. The steel beams of the lintel corroded severely, peeling off the concrete. The lintel mechanism failed. The heavy pressure damaged the walls further. Right : This extensive decay of the teak wood post embedded inside the brickwork was noticed during repairs. Note the gap between the floor and the post. Load transfer in such cases takes place through the bond between the post and the adjoining brickwork

Even making a huge flowerpot is light work, with the powered potter's wheel

POWER FOR THE POTTER

A PORTABLE powered potter's wheel invented by Mr. R. M. Patil of Kolhapur, Maharashtra, promises to make the life of the Indian potter a lot easier. It will not only save him the physical exertion involved in driving the conventional massive potter's wheel, but will also go a long way towards increasing his output and thus making his profession more profitable.

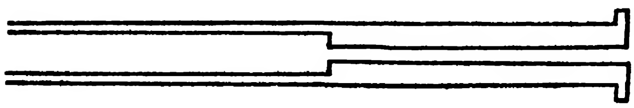
Mr. Patil has developed this device at the instance of the Khadi and Village Industries Commission. It comes in a wooden box, along with water and tool containers and a sturdy handrest. The wheel is powered by a fractional one-eighth HP 230 volts AC motor. It is rotated by an axle through a special gear arrangement comprising two ball bearings and a thrust bearing. The motor has three separate windings for three different speeds of the wheel — slow (50 rpm), medium (80 rpm), and high (150 rpm) — to facilitate moulding of the clay into desired shape. The clay is centred by rotating the wheel at maximum speed, the pot takes shape at medium speed, while finishing touches are given at slow speed. The speed regulator of the wheel is conveniently located for operation by the right leg or by hand.

Mr. Patil has named his device " Shaila ". It can take up to 30 kg of clay, sufficient for making one big size pot at a time. Its power consumption is just half a unit per day of eight working hours. Robust in construction, it weighs 42 kg and measures 15 × 15 × 13 inches.

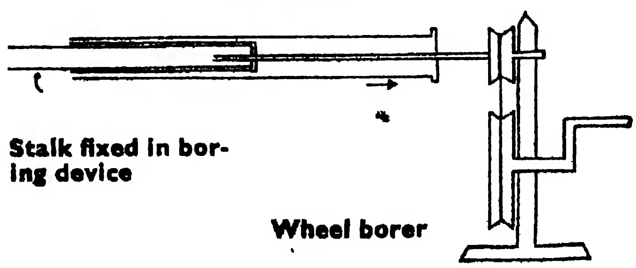
THE JOWAR-STALK PENCIL

YOU wouldn't consider anything useless— not after what Mr. U. S. Patil has done with jowar stalks, which are normally thrown away as waste. He has succeeded in using them for making lead pencils.

Mr. U. S. Patil is a science teacher in Nundurbar, Maharashtra. His aim was to make use of a farm material that is useless to the cattle and that normally goes waste. The upshoots of *jowar* are straight and long—ideal for making pencils. Mr. Patil discards the very thin and thick stalks and selects only the medium-size ones for making pencils. He has worked out the entire process of making pencils in precise



Boring device



details and has also invented a few simple tools for this purpose.

The selected stalks are first cut into pieces of the required length on a wheel cutter. Straight holes are then pierced through the sticks by fitting them in a boring device and forcing a steel wire, fixed on a wheel borer, through it. The diameter of the wire should be equal to that of the writing medium — graphite or crayon — to be inserted. But before that, the core of the stalk is hardened by treatment with a chemical formulation. The inside pith is now beautifully coloured and tough. The outside of the sticks may also be coloured. The sticks are now put in melted wax for 30 minutes, which further impregnates the core and drives out the trapped air bubbles from the pith. The solidified wax is wiped off the surface and removed from the hole by means of the steel wire borer.

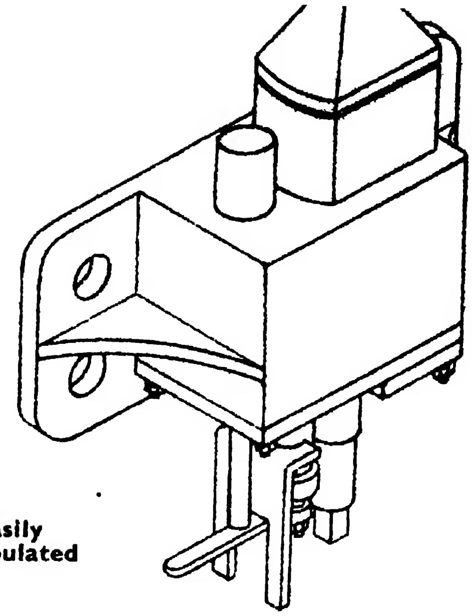
Before insertion of the writing medium, glue is applied inside the hole by means of a feeder. The graphite or crayon is now forced in and the glue allowed to dry. The ends are suitably clipped and the stick rubbed with a cloth to give a better shine.

Mr. Patil's pencil when mass produced will be much cheaper than the conventional wood pencil. Besides putting a waste farm material to use, his invention would save precious soft wood required for the production of the existing types of pencils.

TO GRIP THE FREIGHT CONTAINER

WHEN the Indian Railways decided to go in for Freight Container Service in a big way, a semi-automatic anchorage and locking device invented by Mr. R. N. Seth of the Research, Designs and Standards Organisation, Lucknow, came handy. It facilitated speedier handling of containers at terminals and their safe transport on both rail and road vehicles.

The freight container system has many advantages over the conventional method of transporting goods in loose condition. Apart from simplifying the problem of packaging and minimising damages, it saves on transit time and facilitates handling at terminals and intermediate points of transhipment. The freight container is a large box of standardised dimensions, weighing up to 20 tons, which can be used repeatedly for carrying goods on rail or roadways. It is provided with special fittings in its corners which can fit securely on suitable corner anchorages provided for the purpose on the transport vehicles.



. . . easily manipulated

The patented device of Mr. Seth is meant for fastening these corners of the containers to rail and road transport vehicles. It is fixed on the transport vehicles as an attachment that can engage the standard corner fittings of the containers. It is so designed that when the container is lowered in position it gets automatically locked and firmly anchored. When the container is to be lifted off the vehicle, the device can be easily manipulated to its release position by simply rotating a lock spindle through 90°. When the container has been lifted off, the lock is automatically reset for the next loading operation.

Badiuddin Khan


MUMMY why does their bathroom smell bad, and ours smell so nice?
DARLING... WE USE ODONIL
ODONIL
Odonil Air Purifier soon destroys unpleasant lavatory odours to keep your toilet fresh and fragrant. Choice of many flowery fragrances—Lavender, Jasmine, Mogra etc.
Available in a variety of sizes and models.
BALSARA
—FOR MODERN AIDS TO BETTER LIVING
BALSARA & COMPANY (PRIVATE) LIMITED
43, Medows Street Bombay-1
AIYARS. BLS. 67 REV.

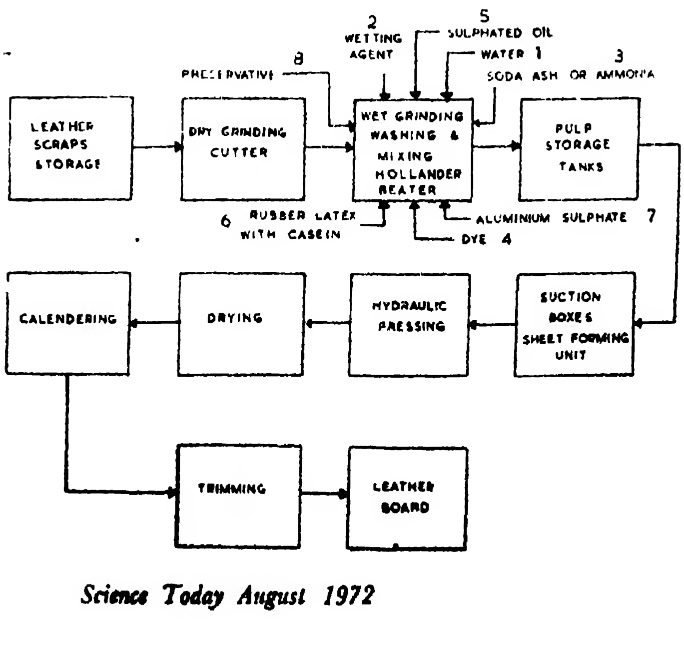
salvaging from waste

LEATHER SCRAPS FIND NEW USES

MAKING leatherboards from waste leather is a new process developed by the Central Leather Research Institute, Madras. Leatherboards are at present made from bark tanned (or vegetable tanned) leather scraps. But in recent years many tanneries have switched over from bark tanning to chrome tanning, and large quantities of chrome tanned leather trimmings and shavings have been accumulating in the tanneries, particularly in eastern India. Except as manure or for glue or washer-making, these trimmings go waste now.

Leatherboards have several uses. In the footwear industry, they are used as insoles, midsoles, stiffeners, heel lifts, etc. They can also be used to make leather goods such as school bags, hand bags and suit-cases, for book-binding, and to some extent, for furnishing, panelling, flooring and for other interior decorative purposes. Of a total estimated demand of 10,000 tonnes a year in the country, only about 5,000 tonnes are now manufactured from bark tanned trimmings.

Based on pilot plant studies at 10 kg of leatherboard a day, the CLRI has worked out the minimum economic scale of production at one tonne a day. The unit cost of production is about Rs. 4·20 (the same board costs Rs. 5 in the market now). The total capital investment, however, runs into a few lakhs. The plant would also need natural rubber latex as one of the raw materials. In combination with synthetic resin, small quantities of rubber latex act as binders. And, though leather trimmings are the main components, jute, cotton, hemp, bagasse, wood pulp, cork, paper, etc are added to the leather pulp depending on the nature of the end product. Cork, for example, makes the board very light; paper helps as stiffener.



The process itself involves a series of operations (see flow diagram) starting with grinding, both dry and wet (for vegetable trimmings a dry cutter is provided in place of wet grinding). The ground pulp is agitated in a Hollander beater and certain reagents added to wash away soluble salts, excess tannings and oils in the pulp. The leather fibres are bound together into a board by precipitating minute particles of rubber around each leather fibre, filtering them over a metallic-nylon sieve and the application of a suction box. The wet sheet is then pressed hydraulically. ■■

Blurs and Bright Spots . . .

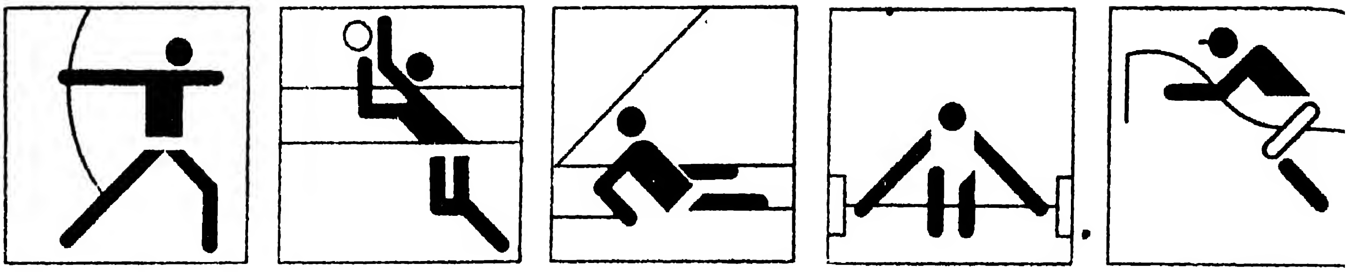
(Contd. from p. 24)

appears that an unusually large number of persons with severe mental disturbances are conceived during the hot months of June, July and August (born in March, April and May) ; and there are indications that these persons are particularly prone to have difficulty in reading, arithmetic and concentration."

McNeil and his colleagues at Lafayette Clinic in Detroit (USA) have studied 469 emotionally disturbed children in 17 treatment centres in the US and Canada. They found the children classified as severely disturbed had a higher frequency of having been conceived in the summer than the mildly disturbed ones. They showed the same results when compared with middle-class non-disturbed children.

The main factor behind the summer-conception madness need not be the summer heat, says McNeil. Several other accompanying factors need to be studied. For instance, humidity, diet, physical activity, amount of clothing, sunlight and diseases.

Hurry up, researchers ! Let the yet-to-be-born ask their mothers not to conceive in the summer. Give them a chance ! ■■



Man was not made to be a runner but...

Every Olympic the story is the same. Records tumble like ninepins. It makes one wonder: what are the limits to which records can go, what is the ultimate in physical performance?

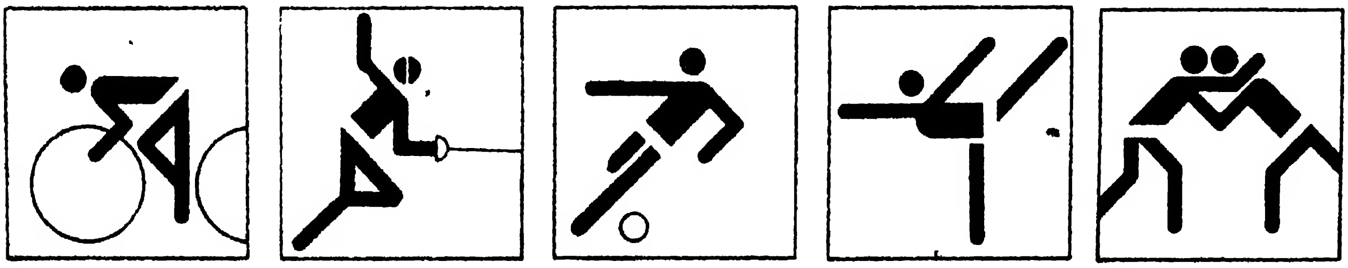
Interesting questions that involve more than a simple answer. Consider the parameters: medical science, technology, hygiene, diets, equipment, training, and, above everything else, physical fitness. But physical fitness is more than possessing a sound body or a sound mind. It is also the ability to handle the body well — under conditions of stress.

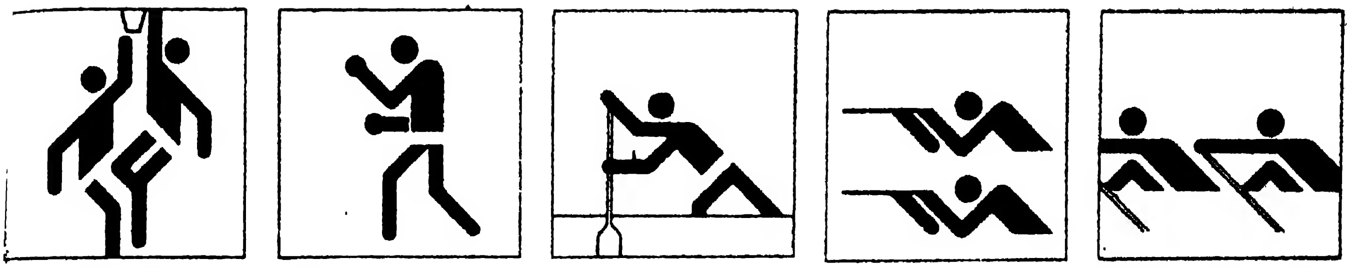
In general, people with long legs and arms and relatively smaller trunks prove to be physically weak in long sustained work. But they might show great speed and endurance at light athletic work. Short people are relatively stronger than tall ones and also quicker — because weight decreases as the cube of the size and force decreases by the square, being proportional to the cross-section of the muscle.

Short heavyset people are remarkably strong and make good weight lifters. The long-legged, " grasshopper " types make good jumpers, runners, vaulters, hurdlers and agility athletes. That means athletes do run to type, within certain limits, though. The important relationships are between muscle mechanics and the grosser organisation of the body for balance, range, direction of movements, leverage for force, speed and power.

Sprint runners are typically light-boned people with long limbs and full-chested bodies. Among the 1928 Olympic runners, 22 of the world's best sprinters showed the following average (1 lb = 0·454 kg; 1″ = 2·54 cm) – 142·3 lbs in weight, 67·9 inches in height, with a weight/height index of 2·17 and a vital capacity of 4300 cc. 400-metre runners were slightly taller (69·2″). Middle distance runners averaged 146·7 lbs weight, 68·9″ in height, 2·19 for body build and 4800 cc for lung capacity. The long distance runners averaged 132·7 lbs in weight, 66·8″ in height, 2·10

OLYMPIAD





for body build and 4300 cc for vital capacity. Jumpers were tall, slender types with long legs. Vaulters, hurdlers and middle distance runners were more or less similar in build.

In fact, slender types make good runners, jumpers and hurdlers. They have rather long legs and slender bodies. Medium types dominate in the decathlon and pentathlon, and among boxers, ball players and swimmers. The massive types make good weight throwers, weight lifters, wrestlers and, up to a point, gymnasts.

The 1932 and 1936 Olympic swimmers too showed certain similarities. Sprint swimmers were forceful, high in arm, leg and body strength. The middle-distance swimmers had an unusually superior vertical and horizontal floating capacity, great vital capacity and a more than average amount of adipose (fatty) tissue. The floating capacity suggests light bones and less dense muscular tissue. Most are above average in strength.

Besides being naturally suited for a particular sport, there is also the matter of training the body. The metabolic processes in the human body are in a continual state of change. Growth and ageing enforce these changes naturally.

THE BODY IN SPORT

Rex D'Rozario

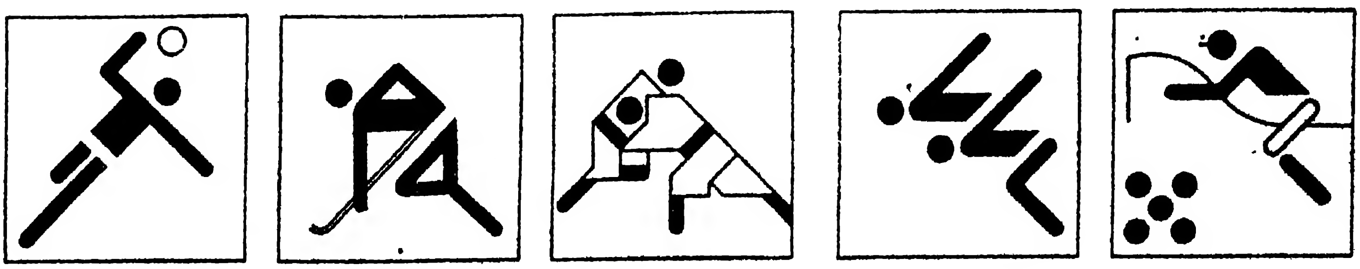
But changes can also be induced through some sort of physical training or stress.

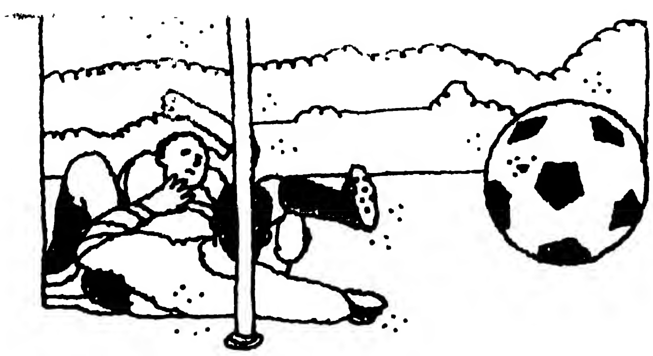
Is this induced change harmful? Do strenuous athletics affect the heart? Do they in any way contribute towards an early death among athletes? These questions have worried athletes and doctors for a long time. Of course, normally athletes live a more adventurous life, taking more risks. Heavy, muscled athletes do not live long, but they are capable of greater feats of strength and power when young. Athletes often put on weight after retiring from their sport. The shorter life may be because of this excess weight.

With systematic training, performance can be improved several fold. Training helps in better adapting each organ to do the work it is built for. Let us take a look at how various organs of the body react to stress and the limits to which they can go.

If the muscles are subjected to repeated stress through work or exercise, the muscular fibres increase in size — a process known as hypertrophy. There is a corresponding increase in the supply of blood to the muscles. This leads to a gain in strength, characterised by the ability to perform more contractions, and to repeat contractions more rapidly. Powerful contractions mean a gain in power, rapid, repeated contractions mean a gain in speed. The ability to perform for a longer time indicates a gain in endurance.

In a sedentary person, a large chunk of muscular movements is a waste in terms of energy expenditure and precision. Physical training eliminates these wastes and improves strength, flexibility, reaction time, balance





and other specific neuro-muscular skills associated with a particular sport. This results in more complete relaxation, proper breathing and simple, automatic movements.

In the body, 22·6 per cent of a total 13 hp of chemical energy is developed as mechanical energy. In sprint running, the mechanical equivalent will be 2·94 hp. In this total, the important factors are: kinetic energy of the arms and legs (1·67 hp), checking arms and legs (0·67 hp), gravity (0·10 hp), wind resistance (0·13 hp) and contact of foot with ground (0·37 hp).

In the case of the heart, cardiac enlargements occur because of pre-existing diseases, not because of the strain of strenuous exercises ; exercise does not affect the heart muscles. If, at times, there is an increase in cardiac bulk, this increase is in proportion with the development of the skeletal muscles.

The heart of a body-trained person has many specific characteristics. Its stroke volume — the amount of blood ejected from the heart at each contraction — is increased. That means the heart contracts more powerfully and empties itself more completely with each contraction. The heart rate during rest is also much lower in an athlete. D. N. Mathur, in a study of Indian athletes, observed an average heart rate of 60 beats per minute with one long distance runner going as low as 40 beats per minute. The normal resting heart rate of athletes may range from 74 to 82 beats per minute, with an average of 76 beats per minute. The hearts of athletes are more efficient and can circulate more blood while beating less frequently. Also, the heart rate and blood pressure return to resting level much sooner after a standard exercise.

One prime condition for respiration is that the blood should be oxygenated rapidly. For this, the lungs should take in air with speed and transfer oxygen to the blood. A trained athlete may exchange lung gases at a maximum of 90 to 150 litres per minute — a large figure compared to non-athletes. Also, the diffusion of oxygen and carbon dioxide between the lungs and blood is more rapid in athletes.

Athletes participating in strength or power events like sprinting, jumping and weight lifting theoretically require more oxygen to complete their event. However, if the lungs are unable to supply the required amounts of oxygen to the muscles, the muscles contract. They gain energy from anaerobic sources and create phosphate and ATP. Lactic acid accumulates in the muscle causing discomfort. But with the resumption of oxygen after the completion of the event, the lactic acid oxidises and is drained away. This capacity of muscles to work in the absence of oxygen can be achieved only through strength-training exercises like weight-training, short sprints, etc.

For the endurance events, like the long distance runs, the main source for the production of energy to contract muscles is glycogen. Glycogen is the end product of carbohydrate metabolism and is stored in the liver and muscles. It produces energy in the presence of oxygen. Training for endurance events has shown that the maximal oxygen consumption or aerobic work capacity is increased; the athlete can perform a greater amount of work with an adequate oxygen supply.

Another concept is flexibility. It can be most simply defined as the range of possible movements in a joint or a series of joints. The need for flexibility varies with the athletic endeavour; eg it is highest in the case of a gymnast. A hurdler must have the best possible hip-flexion (hip-extension) flexibility. In swimming, shoulder and ankle flexibility are very important. The important points are how quickly and easily a joint can be moved.

The most strenuous physical exertion seldom hurts anyone, not even youngsters. Untrained people normally give up strenuous exercise not because they cannot withstand the discomfort and pain but because they are psychologically unprepared for the stress. When muscles are overloaded, they fatigue locally at the motor end-plates. If exercises are severe

The crural index of man (the ratio of the lower leg length × 100 to the length of the thigh), which ranges from 82 to 90, places him in the slow-running class — with the camel, bear, chimpanzee and gorilla. In man, the crural index is high just before adolescence, approaching 90. It diminishes to 84 in the adult.

A LOOK AT THE BODY

It is the muscle that converts chemical energy into mechanical energy in the form of a movement or the tension of holding and stabilising. It stores essential materials like ATP and is constantly washed by blood which brings in oxygen and takes away carbon dioxide. Any activity man performs is done by two processes; the aerobic (oxygen dependent) and anaerobic (oxygen independent). The two processes are developed to a different degree of perfection in different individuals.

The energy requirements of the muscles are very high during sport activities. Four-fifths of the volume of blood may be diverted to the muscles during severe physical activity while there is a concurrent vasoconstriction of the blood vessels of the skin and other parts of the body where the need is not so urgent. In warm climates like in India, where it is essential for the body to lose heat, the skin functions to produce sweat and acts as a surface from which heat is lost. This is one of the reasons why performances in such climates do not reach the peak, especially for those sports which rely on aerobic processes.

There have been theories that, in a trained individual, movements are mediated more by the use of γ (small neuron) loop, rather than by α (large neuron) initiation. But recent works show that there is a programmed excitation of α motor cells in the spinal cord for any learnt activity. There is strong proof of anticipation and a prepared response. With training, the cortical initiation (voluntary component) is reduced and cerebellar function (more automatic) is enhanced in the performance of learnt activities. In sports where there are many participants, the adaptive mechanisms get developed through complex neurophysiological processes.

Endocrine responses to the stresses of competitive sports play a very significant role in the readjustments required. It is believed that physical activity affects kidney function. In an individual, kidney functions assessed by parameters like creatinine clearance, urine volume and the excretion of solutes, acid, formed elements and proteins, improve with moderate exercises. They show reductions only when certain limits of supra-maximal acitivity are reached. In long distance running, significant changes were found in the enzyme LDH-5 (the skeletal muscle and the liver fraction) while no change was seen in LDH-1 and LDH-2, the fractions found in the heart muscles and kidney. That means there is probably less likelihood of damage to heart muscles in conditioned athletes after the physiologic stress of, say, a 10,000-metre run.

Is it possible to predict the peak performances in athletics and sports? The answer is both yes and no. For any Olympic standard event the individual must be genetically well endowed. Also, the more common a particular activity becomes in a population, the greater is the probability of potential champions per thousand emerging from this population. Height and weight and thereby the total surface area of competing athletes at the Olympic Games have shown increases. These may be the factors involved in achieving better records. However, the limitations of energy output in terms of aerobic and anaerobic processes would put limits to any performance.

M. SHAHANI

[M. Shahani is Professor of Physiotherapy at the Seth G. S. Medical College, Bombay.]

enough, the deleterious results are incoordination, probably brought on by disordered synaptic junction in the cord or cerebellum. Sudden stresses, however, affect the middle-aged. They suffer strains in the joints where the tendons join the bones — a result of ageing.

A physiological warm-up of 15 to 29 minutes accelerates the " second wind." With warming-up comes a vasodilation of the muscles including the heart muscles. This helps blood flow. There is less frictional resistance because of an increase in the internal temperature. In the circulatory system, the peripheral resistance lowers in proportion to the dilation of the capillaries. Warming up pushes reserve blood from the abdominal veins into circulation. Emotions and tensions also affect performance by increasing the blood flow and causing stronger nervous

impulses to the body from the brain. There is thus a greater blood flow, greater lung ventilation, a rise in the blood pressure, an acceleration of the pulse rate, the vasodilation of the skin, muscle and heart capillaries and stronger contractions of the heart. All these are mostly nervous adjustments.

Any strenuous exercise must be finished off gradually. After running one shouldn't just lie down but should walk around and flex one's arms for at least 10 minutes. A shower does well. Muscular soreness usually results from a "chilling" after the heating up from strenuous exercises.

Overwork and subsequent fatigue of a chronic nature may lower resistance and lead to infections. Colds are common. If the metabolic rate falls or rises 15 per cent from the normal and if blood pressure rises above 160 or falls below 90, then the athlete is in danger. After moderate exercise or even violent exercise for up to eight minutes, the glycogen store in the liver, the fat deposits in the body and the muscle proteins — all remain intact. Only after extreme strain is blood sugar reduced to half the normal level and body fat burned.

Lord, are these men or machines?

Zatopek, Nurmi, Abebe. Men running mile after tireless mile with facile ease. We wonder. We call them human machines. But it all boils down to a basic advantage — a more efficient respiratory-circulatory capacity and functioning. The right type of body build — the linear type — is essential for endurance running. In short events, speed is dominant. In swimming it is flexibility, a capacity for horizontal floating and a streamlined build. But, in the end, with all sports it is skill which permits the finer adjustments of economy. And, of course, in endurance events, the psychology of will power is a powerful, motivating factor.

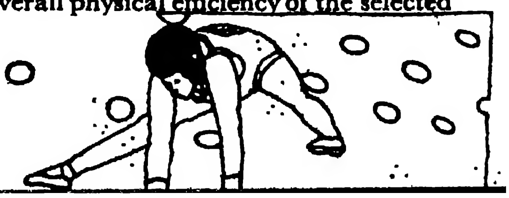
THE CASE OF THE HARE AND THE TORTOISE

In which R. L. ANAND and D. N. MATHUR take a close look at the distressing standard of Indian athletics

Mohinder Singh Gill leapt an eye-catching leap in the hop step and jump. Over 15·8 m and a place among the world's best. Pravin Kumar stands 201 centimetres tall and slung the discuss to a gold medal at the Asian games at Djakarta. Edward Sequeira slashed several seconds from his best timing in his middle distance speciality and hopes to slash several more after some rigorous training abroad. Kamaljit Sandhu raced to another gold in the Asian 400 metres.

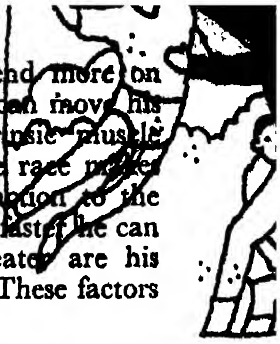
And yet none of them can pursue the prestigious gold at Munich. Why? This is what everyone wonders at. If Japan can do it, if Kenya can do it, why not India. There is talent, there is potential, there is a vast population to choose a champion from. And yet we do not breed champions.

R. L. Anand and D. N. Mathur of the National Institute of Sports tried to find out why. And this is their verdict from the two studies they made to assess the overall physical efficiency of the selected



Training. Coordination. The speed with which the work is performed. Fatigue. Factors that influence the efficiency of performance. In the long-distance events, the factors change. They now include (*i*) the circulatory-respiratory capacity, (*ii*) muscular fitness, (*iii*) the skill in economising the effort of running, (*iv*) low body fat, (*v*) light bones and total body weight, (*vi*) a large carbohydrate reserve, (*vii*) a capacity for dissipating heat, (*viii*) the will power to stick on and (*ix*) the continued coordination of all resources under stress.

In short sprints, there is not enough time for the oxygen inhaled to reach the bloodstream (which takes about 15 seconds). Thus short sprints involve a burning up of inherent energy with the refuelling done after the race. Not so in the long distance run where such metabolic processes of burning up and replenishment take place during the race itself. Thus, in the short distance runs, records depend more on the speed with which the athlete can move his limbs — he must have that intrinsic muscle quality. Also, the shortness of the race makes the reflex time — the athlete's reaction to the starter's pistol — important. The faster he can get off the starting blocks, the greater are his chances of a record performance. These factors can be improved.



In the longer events, from the 200-metre sprint upwards, the oxygen requirement become important. In the 200-metre sprint, the requirement is small — the athlete replenishes the rest of the oxygen requirement in the recovery period that lasts between 30 and 40 minutes. In the longer races, the athlete uses more oxygen than he breathes. The oxygen debt makes itself felt towards the end of the race. Oxygen is first breathed in through the lungs. (The lungs themselves can be made more

participants at the National School Games held on two separate occasions.

The standard of Indian sports is not going down, they argue. On the contrary, we have been making steady progress over the years. But the problem is that this progress is not rapid enough, not as rapid as that made by European countries and Japan. The results in the two competitions show an improvement in individual performances, but there was no general improvement of any significance. The physical efficiency also remained more or less unchanged. The majority of the participants came under the poor or average category in relation to international standards. And these are the reasons attributed:

Coaching and training: The training and coaching schedules of schoolboys and schoolgirls were highly irregular. Among the boys, just a few were trained along scientific lines. This may be due to a dearth of qualified coaches or to the non-utilisation of their services.

Nutritional state: It was poor for almost all competitors. They lacked protein in their diets, and protein builds the strength so essential to athletes.

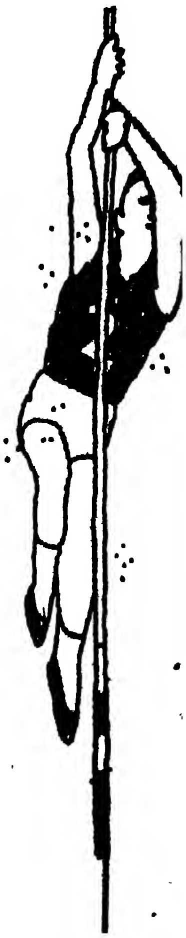
Lack of motivation: After reaching a certain standard in their particular event, competitors just called it a day. They were not motivated enough to pursue a career in athletics. Probably justifiably so. There is little scope for sports in such professional fields as medicine, engineering, etc.

Proper build: When in school, girls and boys seldom have a chance to indulge in physical education or to specialise in any sport for which their body build is inherently suited. Very few of the sprinters in the meets had the necessary developed leg and thigh muscles. Flexibility of the ankle, knee and hip joints, which are of such essence in athletics, can be manipulated in the young. It gets more difficult when the years are padded on. Several advanced countries have gymnastic exercises compulsorily in schools. Such exercises give the desired flexibility to joints in budding athletes at a tender age.

Physiological factors: The NIS conducted several studies on national hockey players. They found the boys lacked strength and sustained speed. To get this strength and speed requires implementing speed training programmes and supplementing them with proper diets with the necessary proteins.

When the values of the respiratory function of several prominent Indian athletes were compared with those of western athletes, the Indians showed lower values in all the parameters. The limitation of Indian athletes is primarily in increasing their ventilation. They just cannot bring it to the level of world class athletes. The reason is probably the lower lung volumes of Indians. To get a higher lung capacity involves several years of systematic training starting from a young age. The same is the case with the maximal oxygen consumption of our athletes which is also lower than that of our western counterparts.

The reasons are mainly scientific and psychological. A person always gives off his best if he wants to give of his best. The wanting to is essential. Motivation is a prime factor. Strength, endurance and skill develop with constant and unbroken practice over long periods. Training cannot be hurried. It has to begin early and stretch over several years. Perhaps, a good start would be to raise training to the level of a science with biomechanics, medicine and research.



THE MEXICAN SHUFFLE

In which a number of athletes got together and re-wrote most of the Olympic record book

There was a controversy. Fire and thunder. Facts and figures. But the post mortems were not as well publicised. The decision to hold the last Olympic Games at Mexico City had astonished many. Why, all knew Mexico City lay snugly in a cool, rarefied atmosphere, 2,250 metres above sea level. Rarefied. That was what caused the controversy. Rarefied meant less oxygen. Less oxygen meant greater difficulties for the long distance runner. Rarefied meant the air was thin enough for the sprinters to feel the difference. The lesser air resistance was an advantage that reflected itself in the records in the 100, 200, 400, 800 metres, the 400 and 1,600 metre relays, the 400 metre hurdles and other assorted field and track events. It will be long before such records are broken or even duplicated at sea level.

About the longer events. Oxygen is of prime importance in the metabolism of athletes since every race over 200 metres depends on the ability of the athlete to transport oxygen to the muscles. The reduction in atmospheric oxygen affected performances. Maybe not in the 800 metres run where the oxygen lack was compensated for by the reduced air resistance and a world record was made. In the 1,500 metres it was a different story. In this race only 25 per cent of the energy comes from anaerobic sources. Thus the Kenyan, Kipchoge Keino, could outrun the world record holder, Jim Ryun. In the 5,000 metres, Gammoudi, a Tunisian, outran a strong field largely because he had spent four years of his pre-Olympic training living in a rarefied world. Here he was followed by Keino and Temu of Kenya. Sea level runners suffered and many dropped out of races. Many drove themselves to the verge of exhaustion. Many collapsed unconscious at the finishing line, overcome by a form of syncope. This was because they could not eliminate the oxygen debt they suffered at the beginning of their races. The story was the same in the longer events.

Acclimatisation is possible. But altitude runners seem to have a greater capacity to extract more oxygen from their blood than sea-level runners. In fact, it seems that no amount of acclimatisation can help the sea level runner beat back this disadvantage. Runners who had spent two years of training in the hills collapsed while the Kenyans and Ethopians trotted healthily along.

For the first time in any Olympic, athletics timings will not be measured by hand in Munich. It will be done by photo-finish cameras in the timing cabin set up 80 metres from the finishing line on the upper edge of the stand. In the case

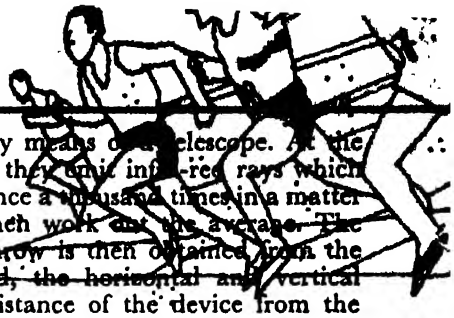
a matter of

of short races, they produce a 9 by 12 cm picture of the finish in 20 seconds and for the longer races a film of the finish up to 40 metres long which can be projected on to a screen of over one square metre 45 seconds after the race. The time scale reproduced at the same time on the photo and film of the finish makes it possible to obtain results to within three-thousandths of a

efficient). From here, the oxygen goes to the blood *via* a one-cell thick membrane between the alveolus and the capillary. Athletes have a higher capacity to transfer oxygen across this membrane.

Training can increase the oxygen uptake considerably at the many different stages. One peculiar way is to subject the athlete to periodic and intermittent stresses of a mild oxygen lack If a miler wishes to train, he should run a quick mile, rest only to get his breath back, and speed off to another quarter mile jog. Jim Ryun, for example, runs nearly two to three hours a day each season. To break records, therefore, the period of training must be lengthened and the various physiological interactions and workings improved upon.

The glamour event of the Olympics, the marathon, was of course, built around a myth. And every year it creates its own. Here is a race that taxes the runner to the utmost. The body is subjected to rigorous stresses over the 42·15 kilometre course (26 miles 385 yards). The danger lies in a depletion of the supply of energy to the muscles. Energy is derived from glucose. Marathon runners run themselves to the verge of collapse because the blood sugar level is drastically reduced. Also, the atmospheric temperature can play a great part in this race especially in a hot environment (because an athlete's body temperature rises at a faster rate after any strenuous exercise). In an experiment in 1961, just before the Cardiff Games, athletes performing in a hot environment had a body temperature of 104°F (40°C), just a degree away from the 105°F at which hyperpyrexia occurs. With hyperpyrexia, the heat produced endogenously within the muscles cannot be dissipated quickly enough by either conduction, radiation or the evaporation of sweat. This



second. To cover a defect arising in the equipment or one runner being completely covered up by another, a television camera will be mounted over the finishing line on the outer hawser of the roof of the stadium at a height of 37 metres.

decimal points

Not only in the field and track events, but also in swimming and cycling. Another Olympic innovation in Munich is that the tape-measure will be replaced by electronic distance measures, similar to those used in surveying. The impact point of the javelin, hammer or discus will be marked by a prismatic reflector, on which the two measuring devices set up in the control centre will be focused by means of a telescope. At the press of a button they emit infra-red rays which measure the distance a thousand times in a matter of seconds and then work out the average. The distance of the throw is then obtained from the distance measured, the horizontal and vertical angles and the distance of the device from the throwing point which is fixed beforehand. The calculation is made by a built-in table computer into which the trigonometrical formula has been programmed. Timing for the swimming will be done by means of an electronic contact which will close when the swimmer applies a pressure of at least 40 grams to the touch-finish strips which are installed at either end of the pool.

BOYS AND GIRLS COME OUT TO PLAY

In which scientists discover whether men are men and women are women

Who is a male and who is a female? The unisex trend has moved into sport too. Look at their hair, their clothes. But that is not the real problem. The greater conundrum lies in telling who are biologically male and female. External manifestations aren't enough. Neither genitalia nor looks can prove to a certainty that a man is a man. It takes more. It takes several tests to do so.

Among these, the earliest was the very simple one discovered by scientists Barr and Bertram in 1949. To determine whether a person is male or female involves delving deeper into several factors that separate the sexes biologically: chromosomes, genitalia, psychology and gonads. Only if the four tally can a man be conclusively male. But, in actuality, very few are totally and undisputably either male or female. Males carry female characteristics and vice versa. Barr and Bertram found that by specially staining a female cell it is possible to give a marked pointer to the sex. The female cell nucleus has a special content called chromatin. If chromatin is absent then further tests are needed to prove the maleness of the cell.

At conception, there are only 23 chromosomes in the egg to begin with. Fertilisation with the sperm enables the egg to build up the 46 chromosome complement of a full cell by combining with the 23 chromosomes present in the sperm. The egg has one female chromosome or X-chromosome. The sperm, however, has either one X- or one Y-chromosome. The sex of the product of fertilisation depends on whether the X- or Y-chromosome of the sperm fertilises the egg first. If it is the X- we have an XX pairing in the fertilised egg to give a female. If the Y- arrives first, the XY pairing produces a male.

But things go wrong. People often have an extra chromosome. Or one less. Or their genitalia might grow abnormally. It is in the third month that genitalia begin to develop. If the foetus is male, the female genitalia remain in the rudimentary stage. In unusual cases they don't. Or there are females with half-developed male genitalia. After the genitalia develop, hormones are secreted from the gonads. Here again, there could be abnormalities. A male getting an extra dose of female hormones could develop secondary feminine characteristics or again vice versa. And there are many such individuals who are lacking or are not totally normal in the strict sense who go through life leading a perfectly normal heterosexual life. When it comes to sport, it is essential to separate the girls from the boys and to also see who are in the limbo of indeterminate sex.

For the purposes of sports, sex tests are, therefore, necessary. But such tests are, to say the least, embarrassing as they often involve a thorough physical check-up. And it is here that the new sex test for the Munich Olympics has provided the much needed face-saving. A team of West German, Belgian and American scientists have standardised their test after ten long years of research. And its simplicity makes one smile. All that is done is a hair from anywhere on the body of an athlete is removed and examined. It is the cells at the root of the hair that are examined. As male and female hair have several basic differences, it does not take long to tell whether the athlete is a man or a woman. And, according to the Olympics Committee, the test is foolproof.

is what happened to the British runner, Jim Peters, at the 1954 Empire Games at Vancouver. Fortunately, he was removed from the track and hospitalised in time.

Physiologically, moderate exercise does not noticeably change the venous blood. The haemoglobin and protein concentration in the serum increase by about 5 to 10 per cent. The oxygen saturation, the carbon dioxide pressure, the pH and the blood sugar remain within normal resting limits. In extreme exercise, expecially under emotional pressure, reserve haemoglobin is probably taken from the spleen to carry oxygen to the tissues. When exhaustion approaches, lactic acid increases by 8 to 10 times from the resting levels and alkaline bicarbonates decrease by one-half. The oxygen saturation may increase as also the temperature which rises to 102 °F (39°C). Otherwise, the blood of runners differs very little from that of others in normal conditions.

It is known that severe muscular exertion increases the weight capacity of the heart, which may extend to the state of hypertrophy. But with exertion comes an oxygen debt; with the oxygen debt, the lactic acid in the muscle increases — the amount of lactic acid is in proportion to the work done. Oxygen helps clear the lactic acid. Acid oxidation too is proportionate to the work done. The higher concentrations of acid are more rapidly oxidised. This oxygen intake varies as the square of the lactic acid concentration in the blood. Thus a 5 per cent concentration of lactic acid leads to a 10 per cent increase in oxidation. And in recovery, lactic acid appears as glycogen. Lactic acid does not appear till up to two-thirds of metabolism. After that it is rapid.

Eat meat to beat the world

Does food have a great part to play in performance? The market overflows with high energy foods that manufacturers claim will give you health, strength, vigour and the performance of your life. There are the diet pills, the pep pills, the vitamin pills, the hordes of other pills.

Preoccupation with health foods is not a modern fad — Greek athletes in the fifth century BC wrestled best on a diet of vegetables, figs, mealcakes and cheese — with meat eaten only occasionally. But star athletes have been known to flout such specialised diets and yet put in record performances.

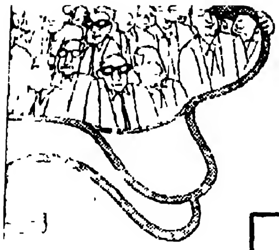
A balanced diet is the best possible energy source for athletes. An excess of any protein, carbohydrate, fat, vitamin, or mineral will not provide extra energy; the body uses just so many calories; the rest is stored as fat. In races of short duration a high energy meal taken before the race is ineffective. Better results are due more to psychological factors — if an athlete thinks he gets extra energy from a certain food, he will do better after eating that food even though this energy may not be available for his use.

But there are some manipulations in diet that can be effected for the good of the athlete. A low-fat, high-carbohydrate diet is good for hard and fast work. Carbohydrates require less oxygen. As a result work is done with one-tenth more efficiency on a carbohydrate diet. In severe stress or emotional strain, adrenalin causes a greater utilisation of carbohydrates than proteins or fats.

It may be possible to improve the general health of an individual. But a total nutrition performance begins normally from birth. Most people get their vitamins from their daily food. Vitamin pills or additives are unnecessary. In fact, overdoses of vitamins A & D can cause side-effects. These fat soluble vitamins might give rise to skin-rash, constipation and headaches. Water soluble vitamins are excreted from the body if taken in excess. Such supplements are useful only during periods of recuperation or ill health.

In an experiment at Michigan State University, USA, it was found that if a person is kept on a no-milk diet, he suffered a depletion of nutrients like calcium and riboflavin. The caloric value of the food he takes can, however, be kept up with other supplements. And what is important is that performance in training does not suffer because of this deficiency. Milk is good for a balanced diet for it has sufficient quantities of protein, calcium, phosphorus and riboflavin.

Man's maximum working power is determined by the supply of oxygen to the heart, muscles and brain and by his skeletal muscles. The rate of oxygen consumption and the total ventilation varies almost directly with the amount of external work performed. On a carbohydrate diet work could be carried on for four hours with only a vague stiffness and soreness in the joints after completion. On a high fat diet, work can go on for only about 90 minutes.■■



— the medical world

REDUCING THE RISK OF "RHESUS" BABIES

EXPECTING mothers in future need have less worry about having a " rhesus " baby. A simple inoculation will ensure that the new-born's red blood cells are not destroyed by the mother's own blood — a disease known as haemolytic anaemia, which results in still-births or severe jaundice in the new-born.

Haemolytic anaemia is a case of blood group incompatibility (see also SCIENCE TODAY, March 1971, p. 23). Human blood can be genetically grouped in various ways. There is, for example, the ABO system. An individual with "O" blood cannot have transfusions of A, B or AB blood. He has substances (antibodies) in his blood plasma which attach themselves to the corpuscles in the donated A, B or AB blood and destroy them. About 85 per cent of the population also contain the Rhesus factor (so called because it was first discovered in Rhesus monkeys); these are Rhesus positive (or Rh +) persons. Those lacking the Rhesus factor are Rhesus negative (or Rh —) persons. If Rh + blood is transfused into a Rh — person, the latter's blood manufactures antibodies which remain in the blood. There may be little or no reaction at first, but after a further transfusion, the antibodies destroy the Rh + blood cells.

Often a Rh — woman has a Rh + baby. (The Rh factor is " dominant " and even if a person has one gene for it, he will carry the factor.) At the time of delivery some of the baby's Rh + blood may leak into the mother's circulation. She manufactures antibodies against Rh + blood. The first baby is not affected because it is born before the antibody is produced. But the antibody in her blood is a threat to subsequent babies. These may be still-born or have foetal hydrops, a widespread oedema of the foetus. The antibodies are dissolved in the blood plasma and can pass across to the unborn baby. But more frequently the new-born infant, apparently normal at birth, develops severe jaundice from accumulation of bilirubin as a result of blood destruction. Due to staining of the brain cells with bile pigments, there is severe brain damage. The treatment of this condition has been to replace the baby's blood with Rh — blood.

ALTHOUGH about 15 per cent of women are Rh —, there are factors which make rhesus babies less common than they would be. For example, in about 20 per cent of potential cases, other blood group systems prevent the Rh system from manifesting itself. It was these naturally occurring protective mechanisms that led to a method of preventing rhesus haemolytic disease.

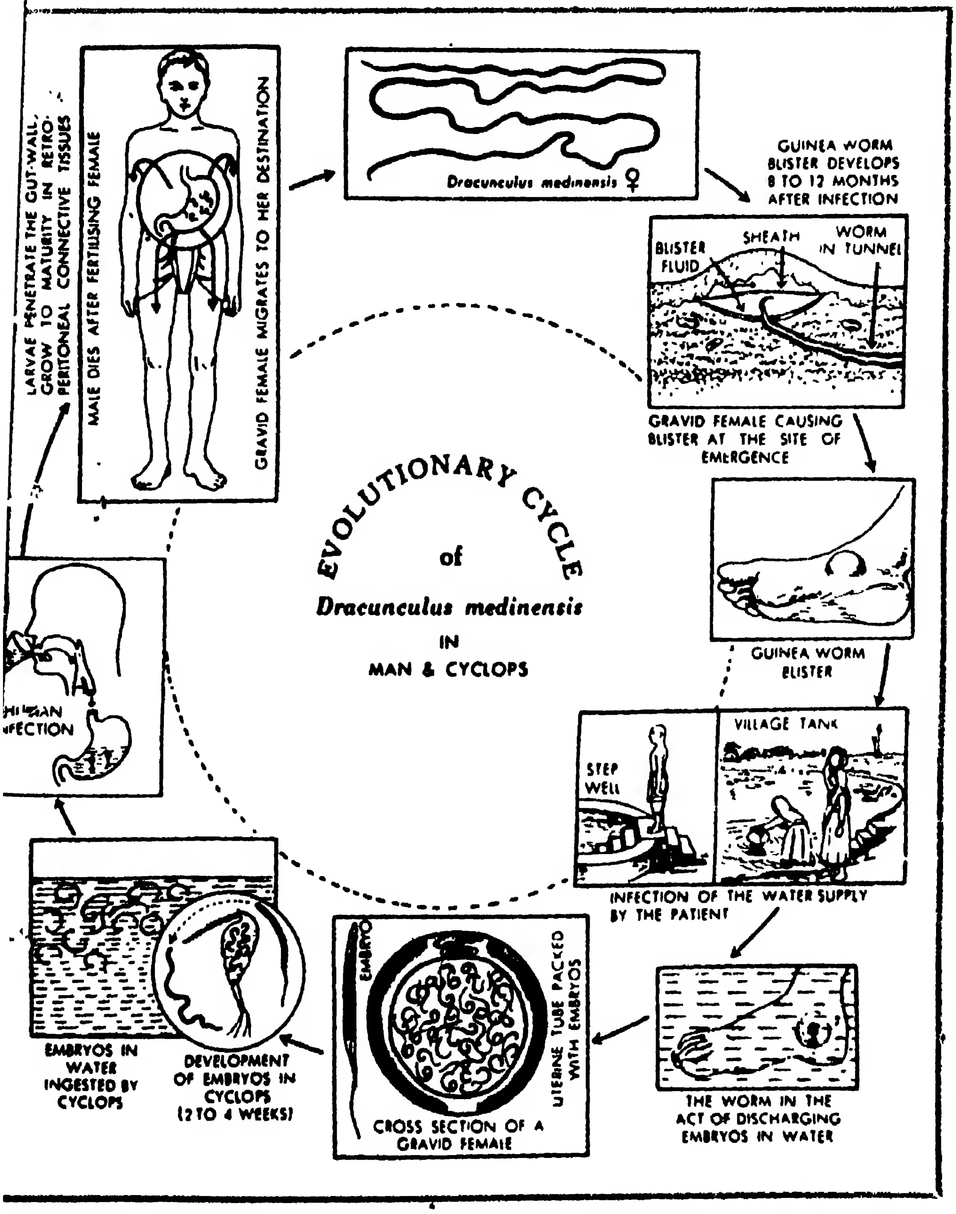
Prof. C. A. Clarke of the Nuffield Unit of Medical Genetics (University of Liverpool) has shown that it was possible to prevent most cases of immunisation by injecting Rh antibody (also called anti-D) after delivery. In two trials which ran from 1964 to 1968, in which 258 women were treated, there were only two cases of immunisation. The dose was 5 ml of anti-D gamma globulin containing about 1000 mg of anti-D, given intra-muscularly within 48 hours of delivery. The mother's blood is examined for antibody six months later. Tests at various centres have shown that treated women who had a second Rh positive baby very rarely produced anti-D antibody. But there is the possibility that a bleed across the placenta at the second or subsequent delivery may stimulate production of antibody — in which case a second inoculation will be required.

The antibody for injection is manufactured by injecting Rh negative males with Rh positive blood.

Expecting mothers should always be tested for rhesus grouping. Writing in the *British Medical Journal*, Prof. Clarke suggests that it may be possible to do away with anti-Rh treatment by preventing the baby from bleeding into the mother's circulation, e g (1) by peeling the placenta off the womb by hand when the after-birth is delayed, (2) by attempts to turn around a poorly positioned baby in the womb before delivery, (3) an excessive number of abdominal examinations of the pregnant mother, (4) caesarian delivery and (5) abortion. Particularly for all Rh negative women who have had abortion it is safe to give anti-Rh.■■

DEVABRATA SETH

guinea worm infection and its problems



Life-cycle of guinea worm [reproduced from "Human Parasites and Parasitic Diseases" (1952) by Dr. K. D. Chatterjee]

DID you know that some five million persons in India are presently hosts to the guinea worm — a long, thread-like parasite ?

In Rajasthan alone, about 2·3 million persons, of a total population of 26 million, have to live with the guinea worm. It is estimated that guinea worm infection (popularly known as ' naru ') of the working population costs the nation Rs. 103·5 million.

These are staggering figures. Worse, there is hardly a total drug for guinea worm infection. In rural areas, which are the most affected, the standard method of dealing with the worm is to tie it to a matchstick when it emerges through the skin and to gradually roll it out inch by inch in the course of a few days or weeks.

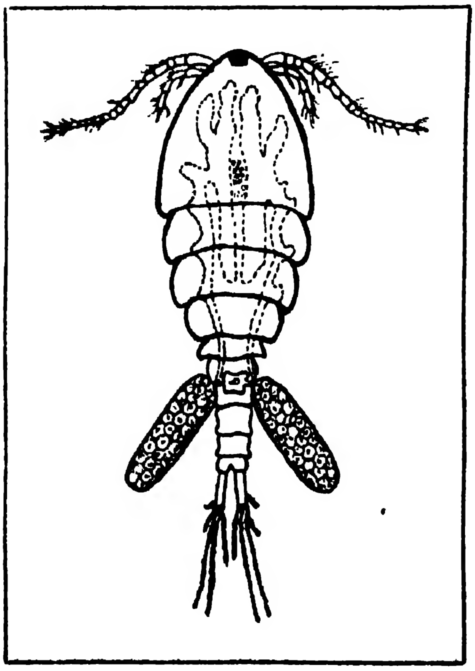
But this is hardly a foolproof treatment. In fact the best method of checking the infection is by prevention — start with the elements that help it grow.

It is interesting how this worm, known to scientists as *Dracunculus medinensis*, gets into the human body. In fact, it spends a small part of its life-cycle in a primitive arthropod called *Cyclops* and the rest in the body cavities and tissues underlying the skin of humans.

It is the female of the species that really matters. It is long and slender (50–120 cm long and 0·09–0·17 cm thick) and can grow longer. The male is much shorter (1·2–2·9 cm long and 0·04 cm thick) and its fate is unknown.

The female matures in eight to twelve months in the body cavities of the human host. During the development of the female, its mouth and intestine atrophy and the body is occupied by two uteri, full of the first rod-like larvae. The gravid female migrates to subcutaneous (below the skin) tissues of the leg, arm, shoulder or trunk — parts most likely to come in contact with water. When it is ready to discharge the larvae, a small papule is formed on the skin at the spot where the worm's mouth approaches the epidermis which ultimately develops into a blister. When this blister comes into contact with water, it ruptures.

A loop of the uterus is prolapsed and either through the mouth or through a rupture of the body-wall of the worm, a swarm of larvae is discharged into the water. They are delicate, 500–750 microns long and 15–20 microns thick, having a long thread-like tail and a striated skin. The discharged larvae move about rather stiffly in water, often coiling on themselves. This apparently attracts *Cyclops* (a primitive aquatic arthropod — the water flea, for example) which feeds on the larvae. Numerous species of *Cyclops* act as suitable intermediate hosts. The ingestion of the infected *Cyclops* in raw unfiltered water provides the opportunity of human infections.



Cyclops

The metamorphosis of the larvae in the body cavity of *Cyclops* requires deeper understanding. After arriving at the midgut of *Cyclops*, the larvae penetrates into the haematocele (blood cavity), then through the two moults of cuticle attains the infective form in about 21 days. The infective larvae are actively motile in the body cavity of *Cyclops* during the first month and then become inactive and tightly coiled, until they are ingested by man or any other susceptible host like horse, dog or ox who get infected by drinking water containing the *Cyclops*. In the alimentary canal of these hosts, the *Cyclops* is digested and the infective larvae are set free. They migrate through the intestinal wall to the loose connective tissues to develop into adult worms in eight to twelve months, thus completing the entire life-cycle.

The peculiarity of guinea worm infection is that the long biological incubation period is almost symptomless. There is no absolute method of diagnosing the infection until the gravid female migrates to the skin. It is only then that all the symptoms and subsequent incapacity of the patient starts. Toxic substances are liberated when the worm reaches the surface of the body and there is a local inflammatory reaction in the form of a blister. The onset of the symptom is of an allergic nature and may be associated with urticaria, erythema, dyspnoea, severe pruritus, giddiness, vomiting or diarrhoea. When the blister bursts open and the worm is pulled out, the symptoms usually abate but in many cases septic conditions develop in the worm's tunnel due to secondary bacterial infections. These may produce abscesses, cellulitis, extreme ulceration and necrosis involving incapacitation. The usual after-effects are arthritis, synovitis, ankylosis and contractures of involved limbs. Moreover people in a highly endemic area are always exposed to re-infection. No immunity develops with this infection. Usually between

Extraction of guinea worm from infected cases. Above, left : Worms extracted (17 in one year) from the body of a woman in rural Rajasthan. Above, right : A worm extracted from the abdomen of a child

The living threads in the body!

Right : Extraction from the thigh region

1 and 5 worms are recovered from an infected person in a season, but in some cases infection loads up to 20 worms are recorded. With all these facts rural folks in affected areas accept the guinea worms fatalistically.

Though attempts have been made by intracutaneous test with antigenic extract of the worm to diagnose the infection during the incubation period, it fails to confirm until a patent infection is established. Those worms which fail to reach the skin surface die and remain calcified and can be diagnosed by X-ray examination.

INCIDENCE. To assess the incidence of guinea worm infection, the author recently visited villages in and around Udaipur district in Rajasthan. This district suffers from scarcity of water and step-wells are the usual source of water-supply for the villagers. This is supposed to be a hyperendemic area of guinea worm infection and literally hundreds of persons could be detected who are suffering from the " fiery serpent " or " dragon worm " infection. For example, Sadada village, 63 km from Udaipur, has approximately 5,000 residents, of whom everyone has been infected at one time or the other. The panchayat dispensary has a

The breeding ground . . .

Step-well in Udaipur District in Rajasthan. Only source of water for the rural population, these wells abound with Cyclops

staff of five, all of whom had been infected last year. It is reported that in Rajasthan, 24 out of 26 districts are affected and there are 2·3 million infected persons in the total population of 26 million. These figures would be grossly true.

Jaswant Singh and Raghavan in 1957 estimated the total number of infected humans in India at 5 million (*Bull. Nat. Ind. Mal. Mosq. 5,* 3). Patnaik and Kapoor in 1967 published a report on the "Incidence and Endemicity of Guinea Worm in India", collected from the health intelligence data during 1950-1964 and the figures are equally revealing (*Indian Journal of Medical Research 55,* 1231). Fairly heavy incidence is reported from Rajasthan, Madhya Pradesh, Maharashtra, Orissa, Andhra Pradesh, Uttar Pradesh, Tamil Nadu and the Andaman and Nicobar Islands. The infection was found in 240 of India's 329 districts.

Recently, Reddy and his associates scanned 10,000 inhabitants of four villages of South India (in 1969) and the infection rate was found to vary between 11 and 54 per cent (*Bulletin of the World Health Organisation 40,* 521). Their survey of the water-supply in an area with a population of 1·87 million showed that in Kurnool district alone 0·5 million people were exposed to the risk of contracting the disease. In fact, it appeared there has been considerable underestimation of the problem in most areas.

Stoll from the Rockefeller Institute assessed the extent of dracunculosis infection in the world at 48·3 million persons (in 1947), against a world population of 2·16 billion (*J. Parasit. 33,* 1). Since then the world population has increased to 3·4 billion, a rise of over 57 per cent. According to him, mankind by extrapolation is at present host to over 75·8 million infections.

In poorer countries, the problem is acute. Here the rate of progress is so slow that it will be impossible to provide clean, piped water-supply and sanitary arrangements for the entire countryside within the near future. The parasite will thrive blissfully, eating away the health of the working population.

PEOPLE rarely die from guinea worm infection. But secondary infections caused by it complicate plenty of cases. Though the incubation period of this infection is between six to ten months, infected persons actually suffer for 55–65 days. Taking an average, a person is incapacitated for 60 days. In India, according to recent figures, the per capita income is Rs. 1·50 per day. On this basis, in Rajasthan alone, the loss in production due to guinea worm infection is Rs. 207 million (Rs. 1·50 × 60 × 2·3 million). If we accept the adult working population to be half the total population, still the annual loss would be around the staggering figure of Rs. 103·5 million. In addition, the apathy and helplessness created by this infection tend to lower the productive capacity of the entire population still further.

EFFECTIVE DRUGS? Till now there has been no fully proved drug against this infection. Even today the primitive method of extracting the worms by rolling them on a stick is practised extensively in the villages. In the absence of modern treatment quacks thrive in the rural areas and the rural population accept it with superstitious belief.

Recently the following compounds have been claimed to be efficacious against *Dracunculus medinensis:* (1) niridazole ; (2) thiabendazole; and (3) metronidazole. There is also a claim that diethylcarbamazine can kill developing stages of the parasite, although it has no action on the adult female. In the absence of a foolproof test for the effectiveness of a particular compound, these claims should be treated with great caution.

CONTROL MEASURES. There are two ways of controlling the disease. The first is by developing immunity in the population in endemic areas with an antigen produced from the worm or the larvae. Though attempts have been made, induced antibody formation has not been successful. Only in experimentally infected rhesus monkeys could antibodies be detected four to eight months before the worms emerged; they reached a maximum level during emergence and vanished two to nine months after patency. Muller in 1970 (*Exbt. Parasit.* *27*, 357) was able to diagnose the dracunculosis infection during the long pre-patent period by indirect fluorescent antibody technique with an antigen produced from larvae.

The second method of control is by killing the *Cyclops* which transmit guinea worm, by physical methods like passing steam or by treatment with chemicals like molluscicides or insect larvicides. Muller in 1970 (*Bull. Wld. Hlth. Org. 42*, 563) also found that " Abate " (0,0,0, 0' — tetramethyl 0, 0' — thiodi-p-phenylene phosphorothioate), a product of the Cyanamid Company, caused 100 per cent mortality of *Cyclops* at a concentration of 0·1 ppm. This compound shows some promise as the mammalian toxicity is very low.

Dracunculosis is still a major medical problem in parts of Africa and Asia. Although there have been several reports of successful treatment as a result of therapeutic trials in man, there has been no readily available laboratory model to study the therapeutic activity and its mode of action. So a suitable procedure has to be developed first to undertake testings of a large number of compounds. Chemical agents must also be found out for the control of *Cyclops*. Cheapness, ease of application and low toxicity to mammals should be the criteria for an effective compound.

DEVABRATA SETH heads the Department of Parasitology at the Sarabhai Research Centre, Baroda, which he started in 1968. After his B Sc and 12 years with the School of Tropical Medicine in Calcutta, he came to Bombay in 1963 to take up hookworm research at the newly-opened CIBA Research Centre. A 1964 UNESCO fellowship took him to the Institute of Parasitology in Prague, where his work on the round worm 'Ascaris lumbricides' was adjudged the best. He has co-authored 33 published papers in his field.

in lighter moments . . .

LOUIS PASTEUR. Chemist by training. Microbe-hunter by profession. A hero by repute. Because he had saved France's wine industry from a sour death (the first application of his pasteurisation process). Because he had pinned down the silkworm parasite and saved the silk industry. Also an enormous egotist by nature, a verbose seeker of glory, a man who considered himself infallible. Eccentricity is tolerable where the mind is great. But Pasteur had allowed himself to be indiscreet — he had published results that were not strictly true, he had let tall claims ride. However, a pair of sharp eyes and a brilliant brain were watching his work closely in Germany. He was Robert Koch.

The two giants met at a conference in Geneva in 1882. Pasteur was on the stage, reading his paper on his revolutionary anthrax vaccine and his own glory. Koch sat near the dais, his eyes smiling behind gold-rimmed spectacles. Pasteur was too self-conscious a man to miss the mockery; also he knew Koch was right. He challenged Koch to open debate. But, no, not on the stage, Koch replied. He was no orator. He would debate in writing.

He did write. In a series of articles he described his own tests on Pasteur's anthrax vaccines which he had found to be ineffective. Also the vaccine was not pure anthrax germs — several other microbes had free pasture there. He called the suppression of bad results unethical. " Such goings-on are perhaps suitable for the advertising of a business house, but science should reject them vigorously ", Koch wrote.

Naturally, Pasteur blew his top. " For 20 years before Koch's scientific birth in 1876, " he replied, " it has been my one occupation to isolate and grow microbes in a pure state, and, therefore, Koch's insinuations that I do not know how to make pure culturations cannot be taken seriously ". No arguments, no points of reasoning. And his indignation swept over France, as if Koch's impertinence had been a slap on the Nation's face. " Who is Robert Koch ? " France heaved. " What else can you expect from a nasty little German ? " Apply the balm, soothe the genius. Pasteur was promptly elected to the *Academie Francaise* — the highest honour in France.

New! Blue top

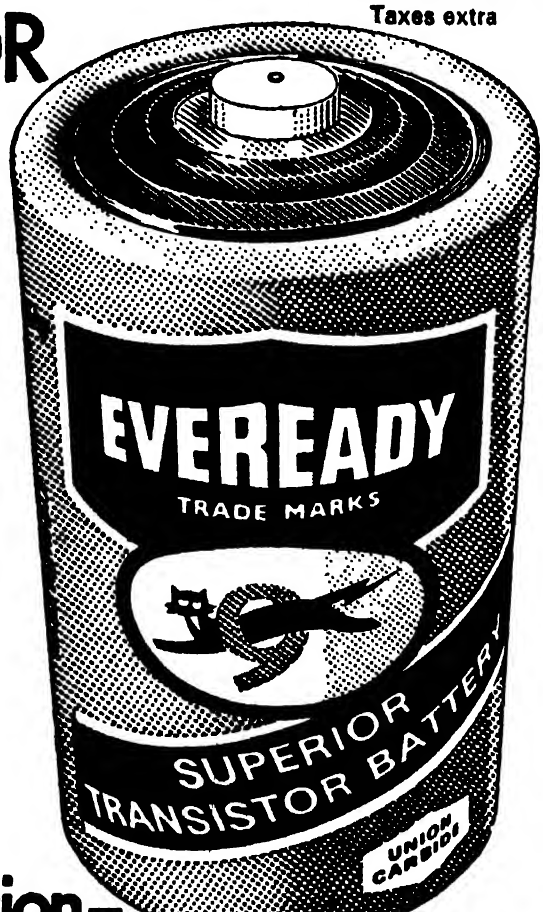
EVEREADY

TRADE MARK

1055

Price Rs.1.55
Taxes extra

TRANSISTOR BATTERY



Now, get better, distortion-free reception from your transistor with 'Eveready' 1055. Because 1055 contains a unique electrolytic depolarizer that makes for greater, more efficient power generation.

Reduces distortion– Improves reception

UNION CARBIDE

books

Practical Transistor Servicing by William C. Caldwell (D. B. Taraporevala Sons & Co Pvt Ltd, Bombay 1, First Indian Reprint 1971, Rs. 11.)

A useful book, more as a guide, for those who already know the principles and operations of transistorised receivers and who wish to understand the subject from the servicing point of view..

Beginning with how the transistor functions and how it is used in various stages of the receivers, it includes the use of signal generators and signal tracers in finding a defective stage. The later chapters explain how to locate a fault by measuring the voltages at various locations in the receiver and comparing them with their normal values.

One complete chapter is devoted to the most simple methods of testing transistors. The book ends with examples of most common faults associated with transistorised receivers and their step by step analysis. An excellent aid for trouble-shooters.

Tape Recorders—How They Work by Charles G. Westcott and Richard F. Dubbe (D. B. Taraporevala Sons & Co Pvt Ltd, First Indian Reprint 1971, Rs. 11.95.)

Another book — rather good — to help you understand tape recorders. It starts with the history, then progresses through detailed explanation of construction and operation of motors, record/playback and erase heads and tape-driving mechanism. The various electronic stages such as the amplifier, oscillator and recording level indicator are also explained in detail. The real worth of the book lies in the manner in which the material is presented. The text, drawings, photographs and a whole lot of professionally used vacuum tubes as well as transistorised circuit stages make the book an excellent servicing guide.

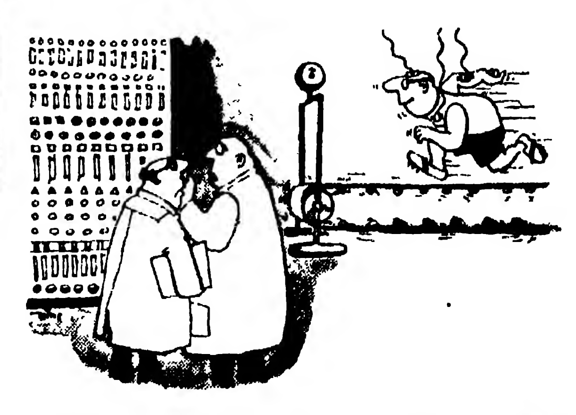
Anil V. Borkar

A Question of Madness by Zhores A. Medvedev and Roy A. Medvedev. Translated from the Russian by Ellen de Kadt (Macmillan, London; 1971; pp. 223; £2.75.)

This is a significant book for all those who value intellectual freedom and the right to dissent. The whole affair has an uncomfortable resemblance to the Lysenko affair and is a grim reminder that the rulers of the USSR in spite of the liberalisation that has taken place since Stalin's days, are still intolerant of scientists who fail to toe the official line. The critics of Lysenko's plant breeding theories were visited by punishments like demotion. Zhores A. Medvedev, a Soviet scientist who did not subscribe to Prof. Snezhnevsky's unitary Pavlovian theory of schizophrenia, was subjected to forcible psychiatric treatment for 19 days in a Russian district mental hospital. In contrast to what would have happened a couple of decades ago, a large body of Soviet fellow scientists and intellectuals came out in Medvedev's support.

The Biology of Affluence. Ed. George Smith and John C. Smith (Oliver and Boyd, 14 High Street, Edinburgh; 1972; pp. 126; £1.95.)

Affluence, no less than poverty, has its problems. Man starts worrying whether he is taking the right types of foods, whether he gets enough vitamin E in his diet, and so on. There are the organic food faddists who favour eating foods raised with only organic or natural manures, and those who are preoccupied with the results of excess on bodily functions — not to mention the more vocal pollution-wallahs. On the whole, this is a stimulating collection of essays, based on a symposium held in Scotland, on the disharmony between man and his modern environment.



"He is too good. Let's drop him from the Olympic team. This is the sixth computer he has blown."

looking back...

did the stars foretell?

JONS JAKOB BERZELIUS (20 August 1779): Today even laymen know that "H_2O" is the chemical term for water. But not so long ago, chemists were using different names for the same compound, and there was not even a standardised system of naming — one of the prime requisites in science for avoiding confusion. To Berzelius we owe the modern system of using the capital initial letters of the names of the elements as symbols. He introduced this system in a paper on nomenclature reform, based on Latin names, in 1811.

Berzelius, a Swede, is best known for his contributions to chemical analysis. Using such commonplace laboratory equipment as wash bottles, filter-paper water-baths and rubber tubing, he discovered three new elements — thorium, cerium and selenium; he prepared silicon, isolated zirconium and analysed over 2,000 chemical substances. He also showed that the products of plant and animal life were equally subject to the laws of chemistry as minerals.

He was the first to link chemistry with electricity; studying electrolytic phenomena, he arrived at the view that the forces that combine two elements to form a compound are partly electrical.

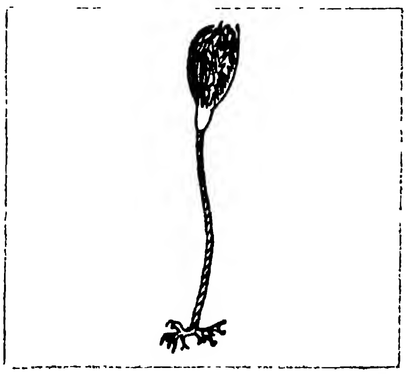
Berzelius also made the discovery that certain substances take part in chemical reactions and even speed them up, but are themselves unchanged in the process. These substances he named catalysts.

He died on 7 August 1848.

GEORGES CUVIER (23 August 1769): "Tell me what you eat, and I'll say what you are," was the boast of Cuvier. He meant that by knowing what sort of food an animal ate, it was possible to have a pretty good idea of its anatomy. Thus, an animal which ate grass should have fairly sturdy dentition.

He saw that the older a fossil and the deeper the rock in which it was buried, the more different it was from modern life forms. To account for the difference he suggested that the earth was periodically subject to floods, and after each flood, life was created anew. The last flood was that described in Genesis; and in this catastrophe some living beings had miraculously survived.

Cuvier extended his theory of catastrophe to geology, too; and to explain the fact that each stratum of rock is different from others and not continuous, as the fossils in them show, he again brought in his catastrophic floods.



Classification is a tricky business. This "sea-lily" is actually a Crinoid, a relative of the star-fish

Cuvier classified animals into four groups — Vertebrata, Mollusca, Articulata and Radiata — on the basis of their internal parts. While his classification is no longer valid, he can be regarded as the founder of comparative anatomy. He died on 13 May 1832.

ALEXANDER FLEMING (6 August 1881): Fleming's career is an illustration of Pasteur's dictum, "Fortune favours the prepared mind."

Fleming had had sufficient preparation for the great discovery associated with his name. After graduating in medicine from St. Mary's School he was fortunate enough to study under Almroth Wright, who had discovered that disease bacteria were destroyed not merely by the phagocytes in human blood: the latter contained a substance "opsonin" which helped the phagocytes do the job. Fleming went on to prove that body fluids like blood, tears, saliva, mother's milk contained a substance ("lysozyme") — probably a ferment — which was inimical to bacteria.

In 1928 he noticed that a bacterial culture he had placed near an open window had become contaminated by a bluish mould. Around the mould was a clear, bacteria-free zone. Fleming shrewdly deduced that the mould (called *Penicillium*) had the power of dissolving bacteria, because earlier he had noticed the same effect when a drop of diluted nasal mucus was added to a bacterial colony.

In 1937, Prof. Florey and Dr. Chain, who had read Fleming's report on penicillin (the substance produced by the bluish mould) tried it on animals and met with success. Then they tried it on a human being, and again penicillin scored.

In 1941, with Britain at war, Florey went to the United States, where he got manufacturers interested in the "antibiotic". It was mass-produced there, and saved thousands of valuable lives in the War.

Fleming was knighted, and in 1945 received the Nobel Prize for Medicine for his achievement. He died in 1955.

JEAN BAPTISTE LAMARCK (1 August 1744): Linnaeus (see SCIENCE TODAY, May 1972, p. 52) left the classification of invertebrates in a mess. It was left to Lamarck to bring some order to it. He was also the first to use the terms "invertebrate" and "vertebrate."

Making a thorough study of living and fossil forms of life, he showed a natural continuous evolutionary descent, with species and genera merging into one another. Species, according to him, were alterable and the more complex forms were developed from the earlier simpler ones. Here we have the germs of the modern theory of evolution.

As for the mechanism of evolution, Lamarck declared that it was by a process of use and disuse. He gave the example of the recently discovered giraffe. This, he said, was evolved from creatures with short necks which stretched their necks to browse on the leaves of tall trees. Stretching made the necks a trifle longer, and this increase was inherited by the offspring. By this process, every succeeding generation had a longer neck, and so finally came the long-necked giraffe.

It is true that necks can be stretched, but how about a complex organ like the eye? This would be useless in an imperfect or less developed form, eg without the lens. Lamarck's theory has failed to explain such cases. But every now and then it is revived. A couple of decades ago, Michurin and Lysenko in the Soviet Union asserted, without ever being able to prove their claims, that acquired characters were indeed inherited.

Lamarck however owes full credit for popularising the idea of evolution, even before Darwin. He was however overshadowed by the non-evolutionist Cuvier. He died on 18 December 1829.

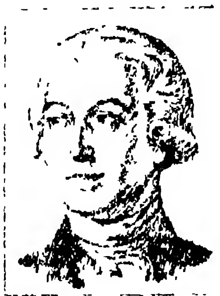
PIERRE DE FERMAT (17 August 1601): In a letter to a friend, Sir Isaac Newton admitted that he had got the idea of his calculus "from Fermat's way of drawing tangents". Fermat also knew the main principles of analytical geometry as early as 1629, eight years before Descartes' "La Geometrie" appeared.

A lawyer by profession, Fermat took to mathematics merely as a hobby without realising that he was cut out for it. He had read most of the early Greek and Arab mathematical works.

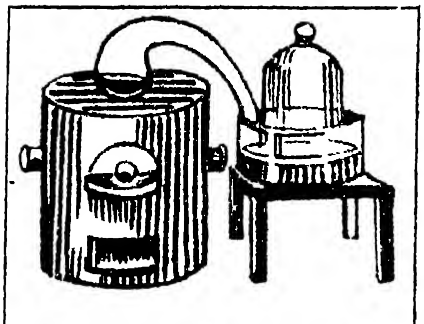
Being slipshod in his methods, Fermat has almost missed the credit for his achievements. He is recognised as a co-founder, with Pascal (see SCIENCE TODAY, June 1972, p. 53) of the mathematical theory of probability. However, he is eminent in science as the founder of the modern theory of numbers. His mind was a factory of theorems, though most of them are without proofs. His Last Theorem ("No integral values of x, y and z can be found to satisfy the equation $x^n + y^n = z^n$ if n is an integer greater than 2") is still without proof.

Fermat did not publish anything during his lifetime and he is known to us through the four-volume "Opera Varia", a collection of his correspondence and notes, published by his son in 1679, five years after his death.

ANTOINE LAURENT LAVOISIER (26 August 1743): "The Republic has no need of scientists", said an official of the French Revolution as he arrested Lavoisier. He was tried for his "antipeople" acts, such as being the executive of a tax-farming agency, and beheaded at the guillotine.



But it was Lavoisier who put chemistry on the road to progress, after purging it of "phlogiston" and such-like theories. In a classic experiment he heated some mercury in a retort connected to a sealed bell jar inverted over a trough of mercury. As the heated mercury turned into a red powder, the level of mercury rose in the bell jar, showing that the volume of air had been reduced. When he removed the red powder and heated it strongly, he found that the gas given off was exactly equal in volume to the air displaced in the bell jar. Lavoisier thus proved that a fraction of air, one-fifth to be exact, is utilised in burning, and also demolished the "phlogiston" theory according to which materials which burned were rich in a substance called phlogiston. This fraction of air Lavoisier named "oxygen" from Greek words meaning "to give rise to acids". (He wrongly thought that all acids contained oxygen).



One-fifth of the air in the bell jar was displaced . . .

Lavoisier extended his work on combustion to body metabolism and inferred that in the course of respiration the carbon and hydrogen in blood combined with the oxygen of air by a process of slow combustion, as a result of which carbon dioxide and water are given off.

His "Elementary Treatise on Chemistry" (1789) was the first modern chemical text-book. He thus introduced precision in chemistry and in fact did for chemistry what Galileo did for physics earlier. Though rightly regarded as the father of modern chemistry, Lavoisier met his downfall by falling foul of one of the lights of the French Revolution — Marat, whose paper Lavoisier, as a member of the French Academy of Sciences, had earlier rejected. When France became a republic, Lavoisier was arrested for tax-farming and executed after a mock trial on 7 May 1794.

S. N. Munshi

You too can do it——

Touch Switch

THE problem with most audio amplifiers is that they have extremely low audio voltages and currents. This, in itself, is not a drawback but such circuits are liable to be affected by any external voltages or currents. Any nearby current-carrying circuits like the AC mains wiring could induce such unwanted currents and voltages into an audio amplifier circuit. All mains supply wiring radiate at power frequencies. If such a radiation is induced in a sensitive part of the amplifier, it gives out a low-pitched, droning sound called a hum. To solve the problem of this hum you could build a very simple touch switch. This device actually uses the same phenomenon to actuate the electronic circuit. The electronic circuit operates the magnetic relay.

A metallic object is connected to the input terminals of the device. If a person touches the object, the very minute AC voltage induced in his body from the mains supply lines will actuate the electronic circuit to operate the relay. The device can be divided in two parts; the first part is a special type of three-stage transistorised amplifier circuit having the electromagnetic relay at its output terminals. The second part, i e the power supply, provides the 12 volts DC power required to operate the amplifier and the relay.

The signal voltage which actuates the electronic circuit is a very minute AC voltage. The first stage of the amplifier amplifies this voltage and feeds it to the detector stage. Here it is converted into its corresponding DC voltage form. The DC voltage is used to trigger the second and third stages of the amplifier to operate the electromagnetic relay.

The sensitivity control is situated in the second stage of the amplifier. This control provides the necessary adjustments to select the level of the actuating signal at which the second and third stages will trigger to operate the relay.

For reliable operation, the metallic object to which the device is connected should be as small as possible and should be electrically isolated from the ground. The cable connecting it to the device must be a special type of cable called a shielded cable.

You will need:

Semiconductors: Tr1 — BC107, 1 No; Tr2 — BC177, 1 No; Tr3 — BC107, 1 No; OA85, 2 Nos; BY126, 1 No. *Relay:* With two change-over contacts, coil resistance 180 ohms or more. *Transformer:* Pri: 230 volts; Sec: 10 volts at 250 milli-amps. *Capacitors:* 0·1 mfd paper or polyster; 100 mfd — 12 volts electrolytic; 250 mfd — 12 volts electrolytic. *Resistors:* (all ½ watt); 10 k; 1 Meg; 1 K; 12 K; 2·2 K; 10 ohms. *Potentiometer:* 50 K ohms. *Misc:* Shielded wire; Hook-up wire; Solder; Group board; Knob; Suitable enclosure etc.

Anil V. Borkar

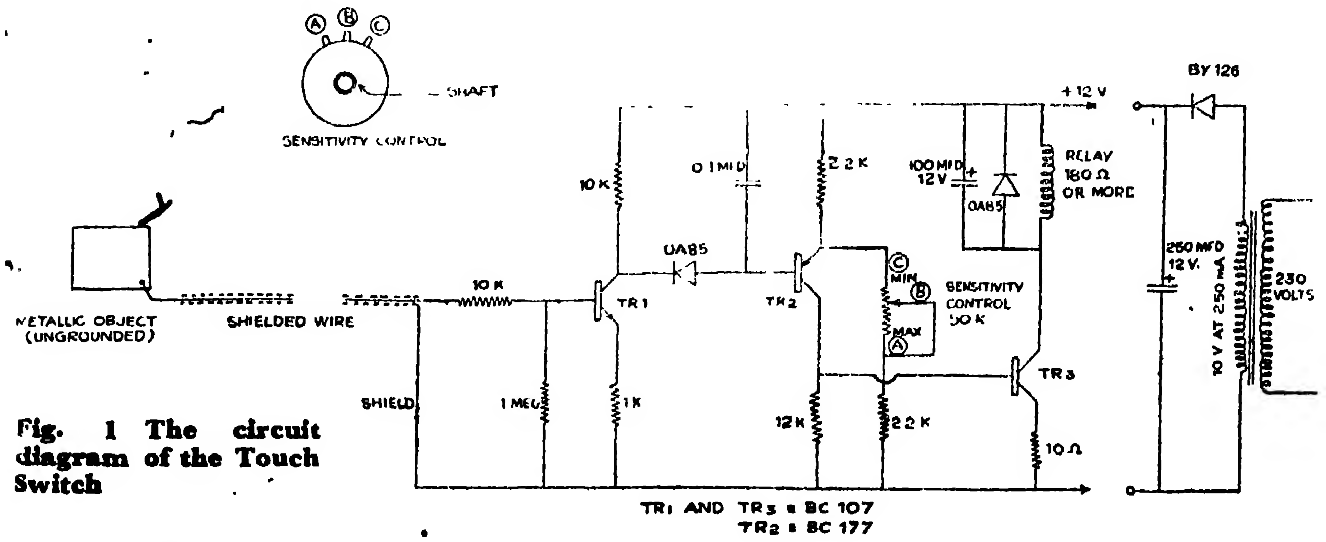


Fig. 1 The circuit diagram of the Touch Switch

Regd. No. MH 1368